



Qualification Testing of Solid Rocket Booster Diagonal Strut Restraint Cable Assembly Part Number 10176–0031–102/103

T.W. Malone

Marshall Space Flight Center, Marshall Space Flight Center, Alabama

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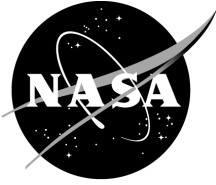
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National Aeronautics and
Space Administration

Marshall Space Flight Center • MSFC, Alabama 35812

September 2006

Acknowledgments

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LIST OF ACRONYMS AND ABBREVIATIONS

ELV	elevated temperature
RT	room temperature
SRB	solid rocket booster
TM	Technical Memorandum
USA	United Space Alliance

TECHNICAL MEMORANDUM

QUALIFICATION TESTING OF SOLID ROCKET BOOSTER DIAGONAL STRUT RESTRAINT CABLE ASSEMBLY PART NUMBER 10176-0031-102/103

1. INTRODUCTION

This Technical Memorandum (TM) presents qualification test results for solid rocket booster (SRB) diagonal strut restraint cable assembly part no. 10176-0031-102/103. During flight, this assembly is exposed to a range of temperatures. MIL-W-83420 defines the breaking strength of the cable to be 798 kg (1,760 lb) at room temperature; however, it does not define cable strength at 669 °C (1,236 °F), the maximum temperature to which the cable is exposed during the first 2 min of flight.¹ The cable, which is able to be built from different corrosion-resistant steel alloys, may also vary in its chemical, physical, and mechanical properties at the tested temperatures.

Analysis of the cable at the tested temperature, when using the standard knockdown factors for untested requirements given in MSFC-HDBK-505, "Structural Strength Program Requirements," produced negative margins of safety.² However, MSFC-HDBK-505 also stipulates conditions where a less conservative safety factor of 1.4 and less conservative knockdown factors are appropriate if they have been verified by testing.² SRB document 90PLN-0064 provides requirements for qualification testing the strut retainer assembly.³

2. BACKGROUND

The restraint cable assembly is a steel cable with two terminal wire-rope clevis ends, pins, and cotter pins. The clevis ends and pins are picked from standard military specification hardware to interface with the external tank attachment ring and the diagonal strut assembly (figs. 1 and 2). The terminal wire-rope clevis ends are swaged onto the steel cable in accordance with MIL-T-6117.⁴

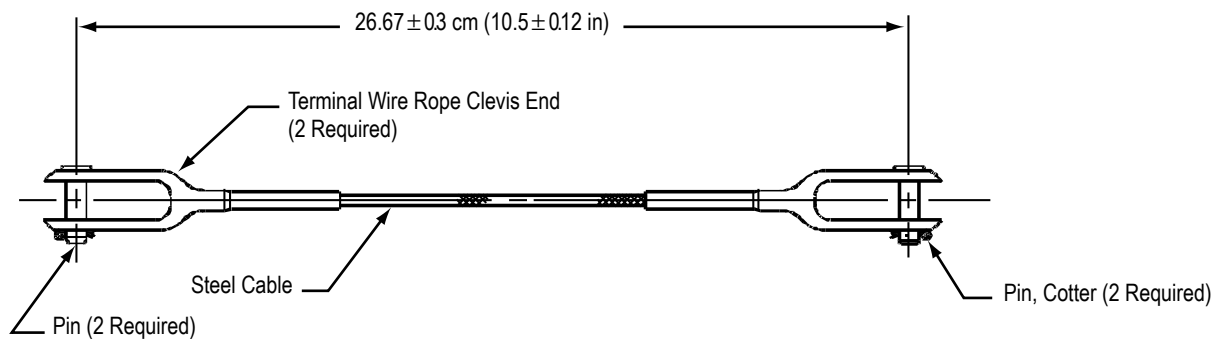


Figure 1. Strut retainer assembly.

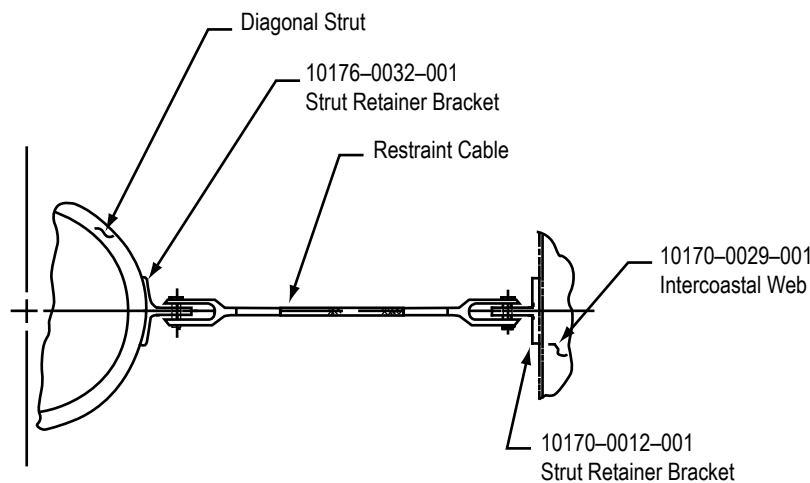


Figure 2. Strut retainer assembly installation.

This TM presents test results for three lots of MIL-W-83420, 0.317-cm (0.125- or 1/8-in) diameter, type 1 (nonjacketed) cable to loads required to restrain the diagonal strut during the first 2 min of flight and, ultimately, to failure.¹ The first lot consisted of available flight cable assemblies that existed in United Space Alliance (USA) stock. The other two lots were obtained from new procurements, with

documentation that the wire ropes are from two different wire lots or spools. Test results qualified the available restraint cable assemblies and all future buys of restraint cables manufactured under the same procurement specifications for flight.

3. TESTING AND EVALUATION

3.1 Testing

Mechanical testing was completed June 6, 2004 and was performed in accordance with ASTM-E-8 and test procedure SRB-QUAL-04-0064 for the first lot of cables.^{5,6} Five restraint cables were each pulled to failure at room temperature and at 671 ± 5 °C ($1,240 \pm 10$ °F) in accordance with the referenced procedure, 90PLN-0064, and memorandum MP41 (04-063).^{3,7} Testing was completed for the other two lots on August 6, 2004. Ten additional restraint cables were each pulled to failure at room temperature and at 677 °C (1,250 °F) in accordance with the referenced procedure and plan.³

Table 1 shows analysis of the test results, including the calculation of a knockdown factor using methods described in chapter 9 of MIL-HDBK-5.⁸

Each cable was photographed before and after testing. All tests at room temperature were videotaped, and appendix A shows still images taken from the videos.

Procedure checklists were used for each test, in accordance with SRB-QUAL-04-0064, and they are shown in appendix B of this TM.⁶

3.2 Evaluation

A value, R , was calculated for each pair of room temperature and elevated temperature tests. This value is the reduced ratio for the peak load tests at the elevated temperature, 677 °C (1,250 °F), and room temperature. Mean and standard deviations were then calculated for the R value.

Table 1. Mechanical test results.

ID	Test Temperature (°F)	Peak Load (lb)	Ratio, r
5369RT-1 (408899)	73	1776.7	–
5369RT-2 (408899)	72	1781.9	–
5369RT-3 (408899)	72	1797.7	–
5369RT-4 (408899)	72	1792.5	–
5369RT-5 (408899)	71	1779.8	–
104236RT-1	71	1900.3	–
104236RT-2	71	1863.3	–
104236RT-3	71	1899.4	–
104236RT-4	71	2008.5	–
104236RT-5	71	1981.6	–
071081RT-1	70	1956.8	–
071081RT-2	70	1954.4	–
071081RT-3	71	1891.5	–
071081RT-4	70	1925.6	–
071081RT-5	71	1939.8	–
Average	–	1883.32	–
5369ELV-6 (408899)	1,250	322.2	0.1813
5369ELV-7 (408899)	1,259	342.1	0.192
5369ELV-8 (408899)	1,258	323	0.1797
5369ELV-9 (408899)	1,254	330.3	0.1843
5369ELV-10 (408899)	1,254	337.8	0.1898
104236ELV-6	1,253	387.8	0.2041
104236ELV-7	1,259	370.6	0.1989
104236ELV-8	1,251	399.8	0.2105
104236ELV-9	1,250	392.7	0.1955
104236ELV-10	1,251	402.4	0.2031
071081ELV-6	1,251	374.7	0.1915
071081ELV-7	1,254	383.2	0.1961
071081ELV-8	1,252	388.8	0.2056
071081ELV-9	1,258	358	0.1859
071081ELV-10	1,240	361.3	0.1863
sum =			2.9
<i>r</i> -bar =			0.1936
<i>s</i> =			0.0094
At 677 °C (1,250 °F), knockdown factor <i>R</i> =			0.1892

At the working temperature of 677 °C (1,250 °F), the lower 95-percent confidence interval estimate, or reduced ratio, of the mean percentage was determined from percentage values for each lot at that temperature. If *r* equals percentage values, *r*-bar equals the average of these values, and *n* equals the number of such percentages, estimated standard deviation, *s*, and reduced ratio, *R*, can be determined using the equation:

$$S^2 = \text{sum}(r - r\text{-bar})^2 / (n - 1) , \quad (1)$$

or

$$S^2 = \left[\text{sum}(r^2) - (\text{sum } r)^2 / n \right] / (n - 1) , \quad (2)$$

and

$$R = r\text{-bar} - ts/n^{1/2} \quad , \quad (3)$$

where t is a 0.95 fractal of the t distribution corresponding to $n-1$ degrees of freedom. In this case, the t used was $t=1.753$ for $\alpha = 0.95$ and $n=30$.

4. CONCLUSIONS

A calculated knockdown factor of 0.1892 was determined for the restraint cables. That value will be used during structural analysis of the restraint cables in the elevated temperature condition. When combined with the minimum breaking strength of 0.317-cm (0.125- or 1/8-in) diameter, type 1 composition rope according to table 1A of MIL-W-83420, this knockdown factor provides a minimum breaking strength of 151 kg (333 lb) at 677 °C (1,250 °F).¹

APPENDIX A—PHOTOGRAPHS BEFORE AND AFTER TESTING

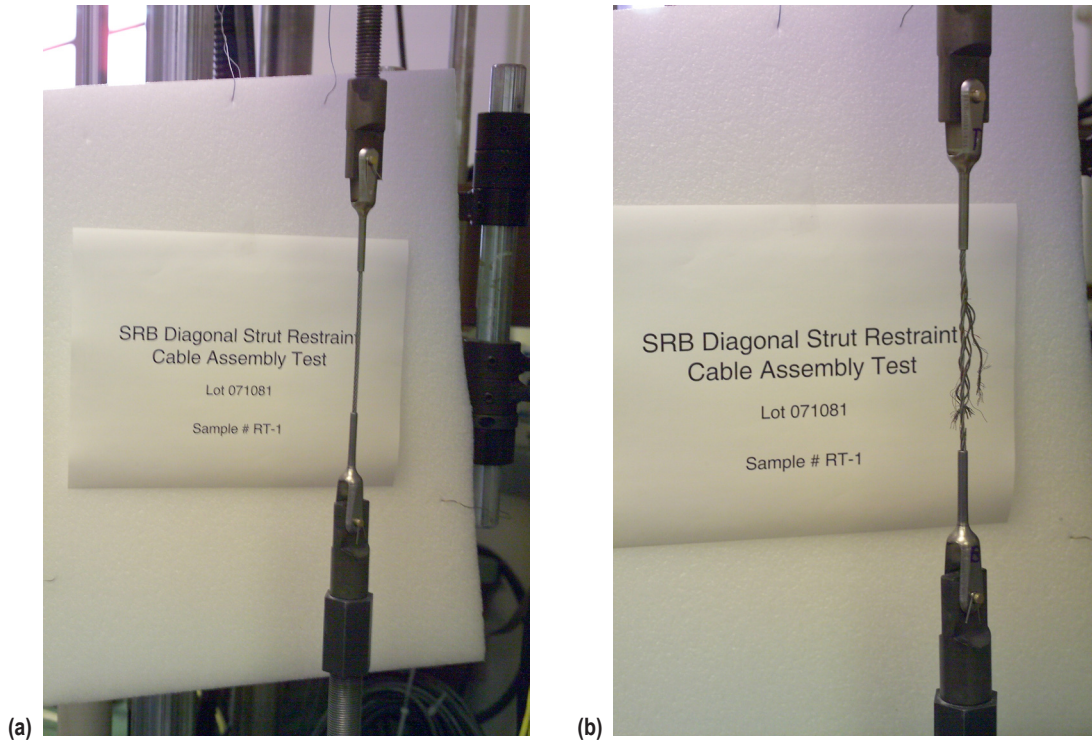


Figure 3. 071081–RT–1 (a) before testing and (b) after testing.

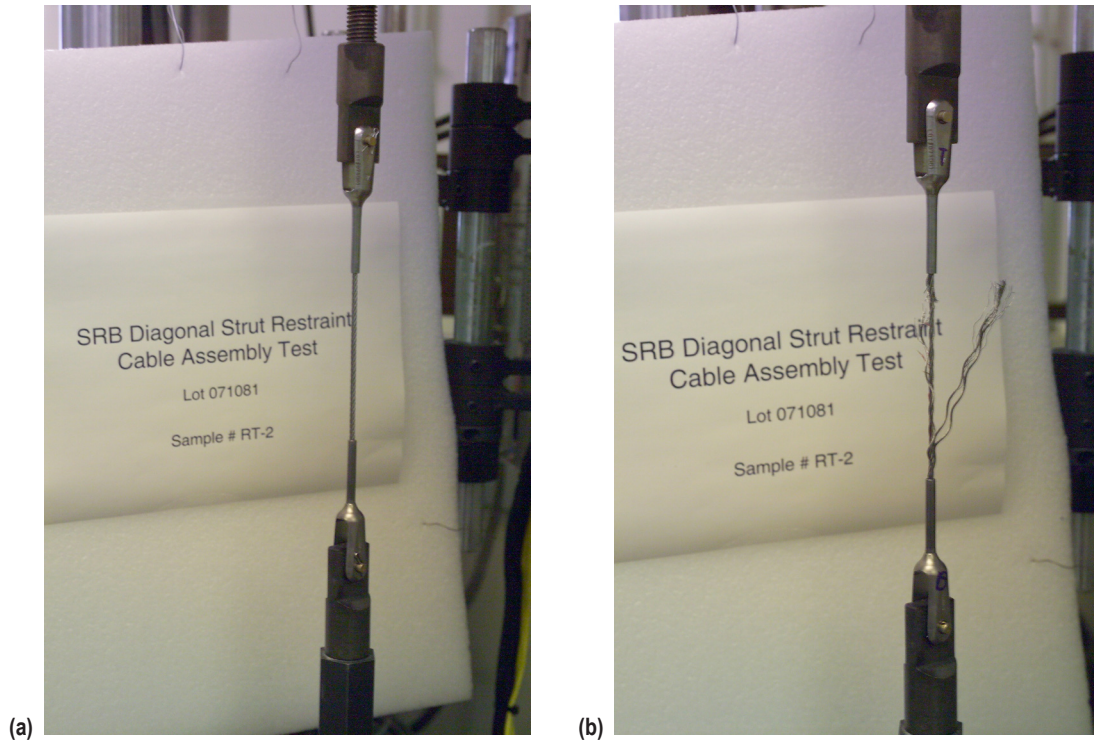


Figure 4. 071081–RT–2 (a) before testing and (b) after testing.

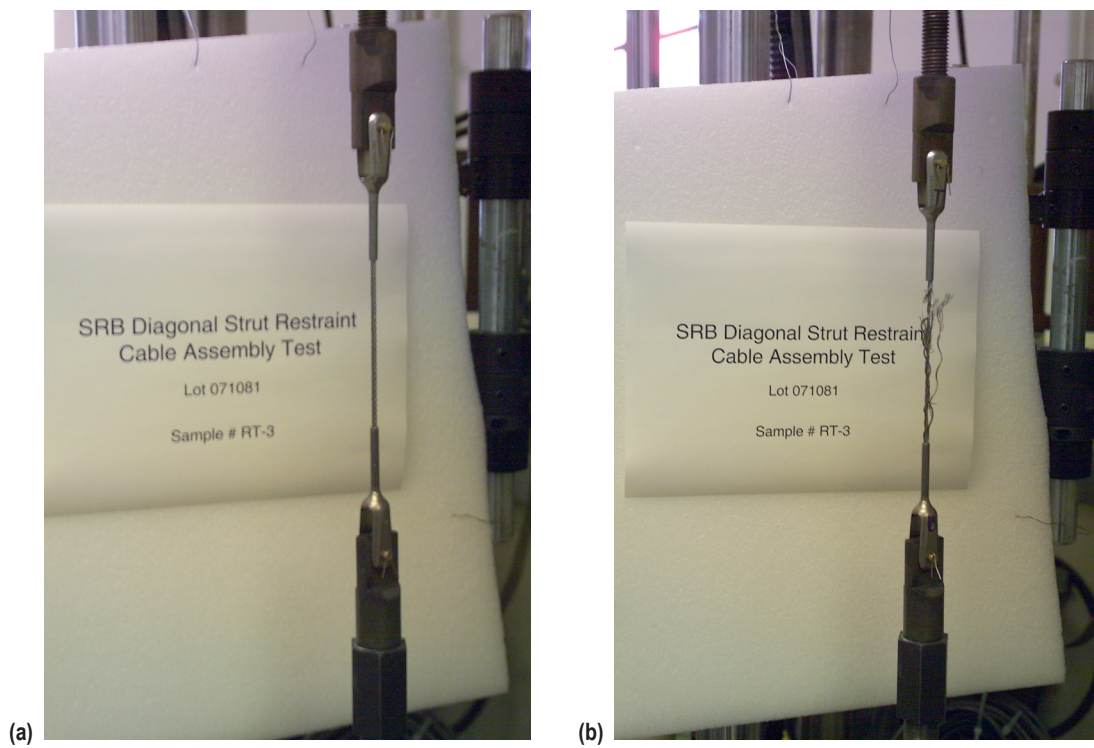


Figure 5. 071081–RT–3 (a) before testing and (b) after testing.

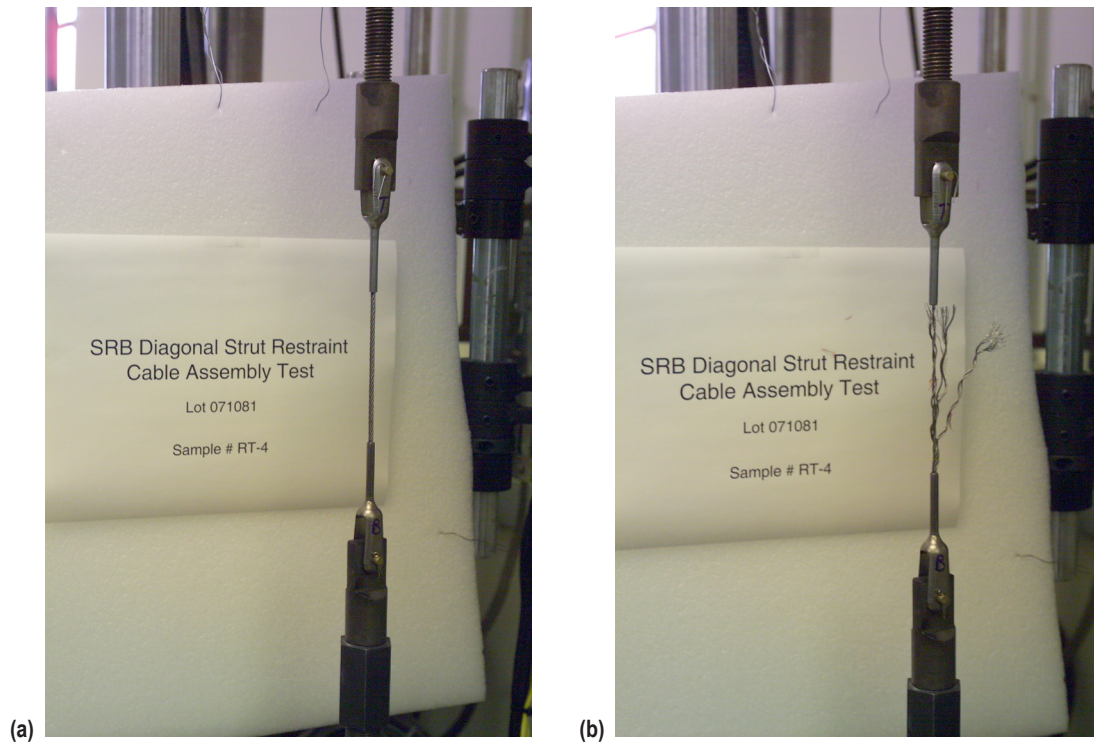


Figure 6. 071081–RT–4 (a) before testing and (b) after testing.

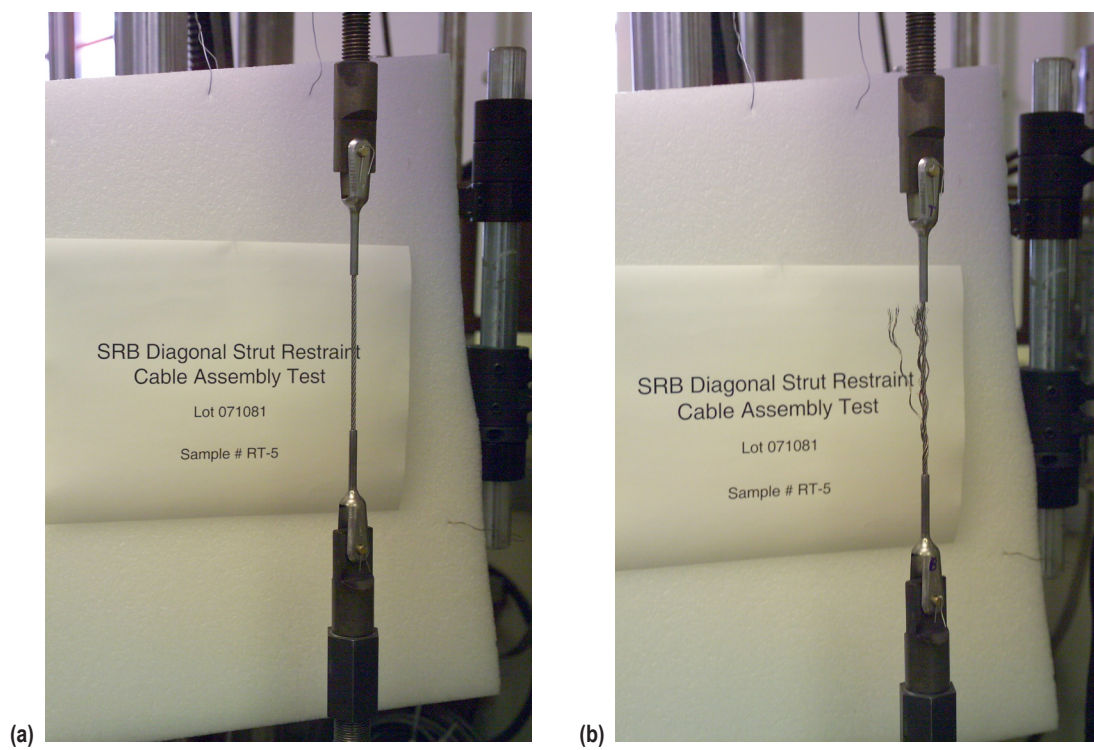


Figure 7. 071081–RT–5 (a) before testing and (b) after testing.

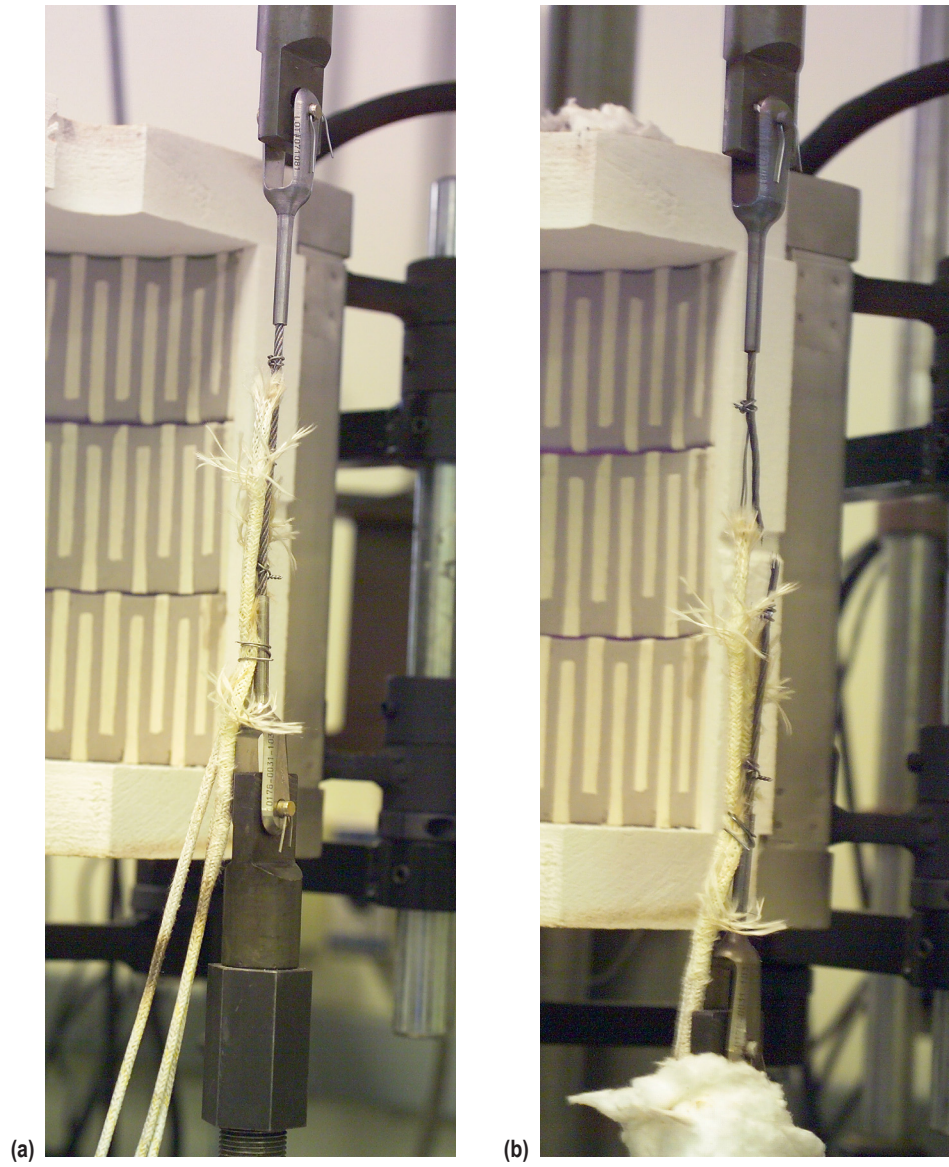


Figure 8. 071081–ELV–6 (a) before testing and (b) after testing.

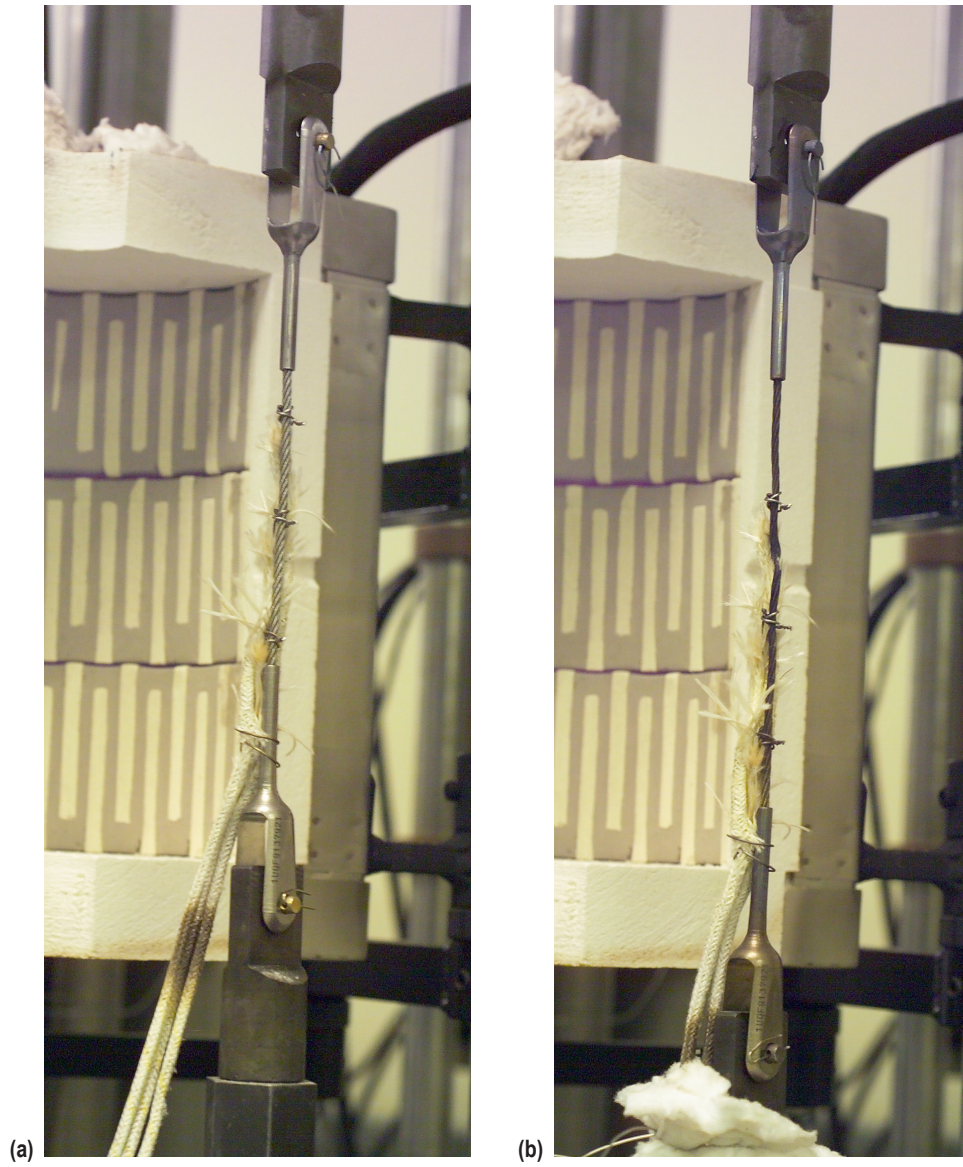


Figure 9. 071081-ELV-7 (a) before testing and (b) after testing.

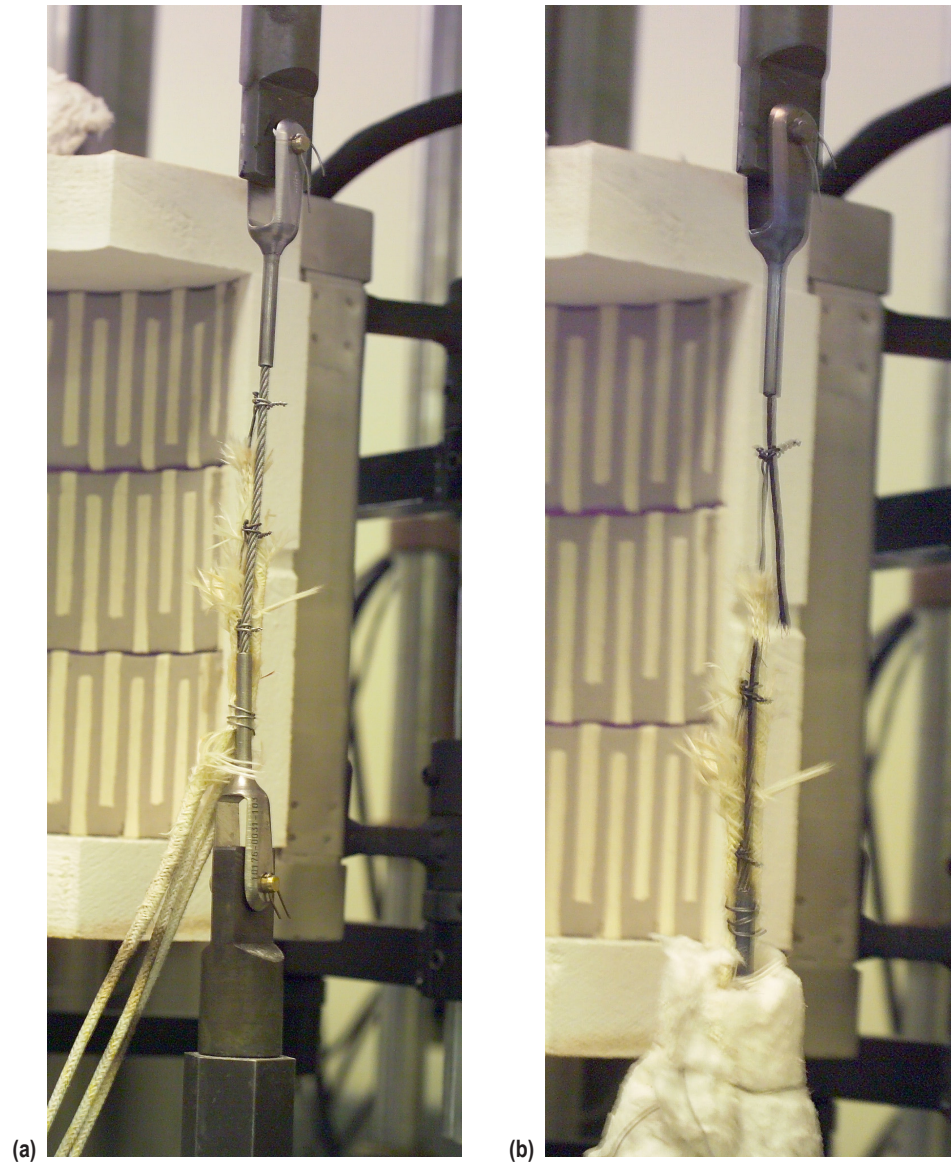


Figure 10. 071081–ELV–8 (a) before testing and (b) after testing.

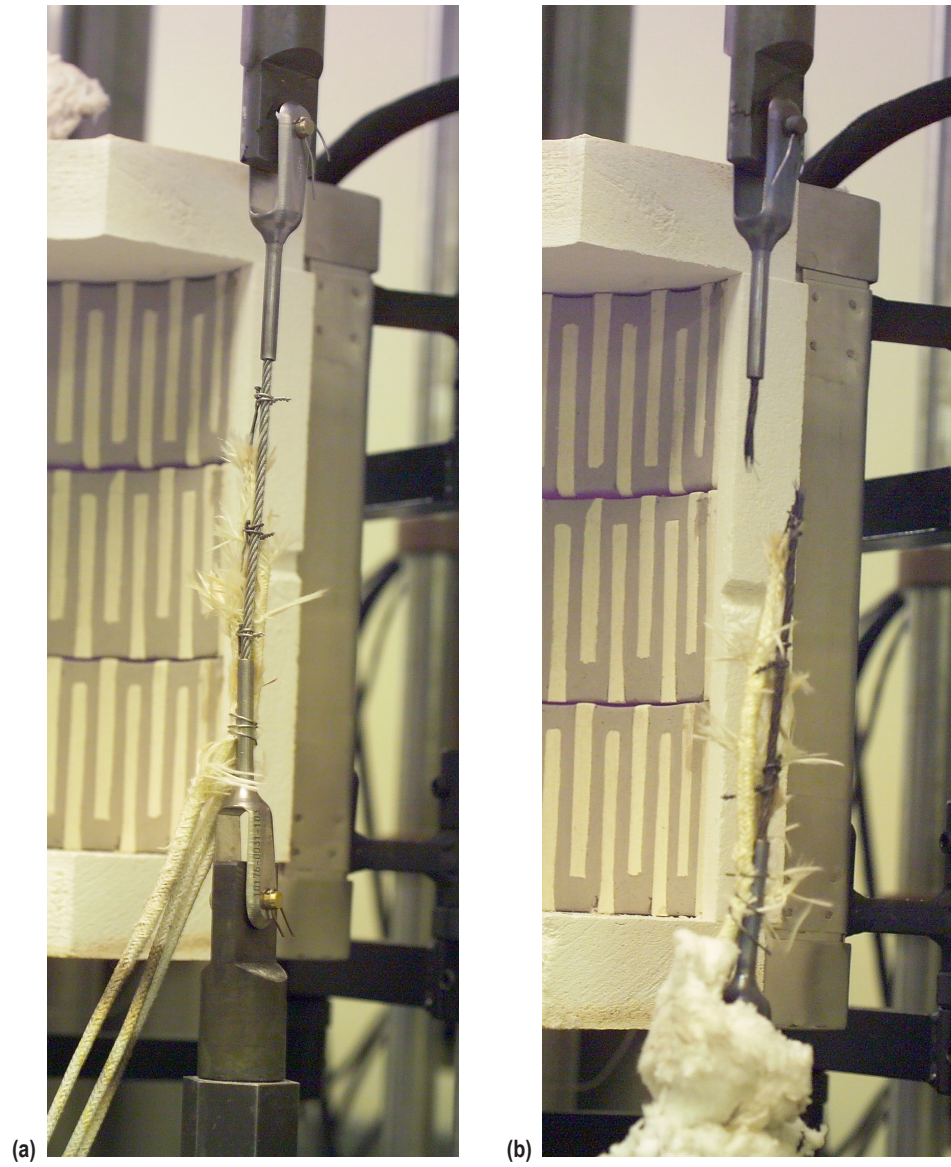


Figure 11. 071081–ELV–9 (a) before testing and (b) after testing.

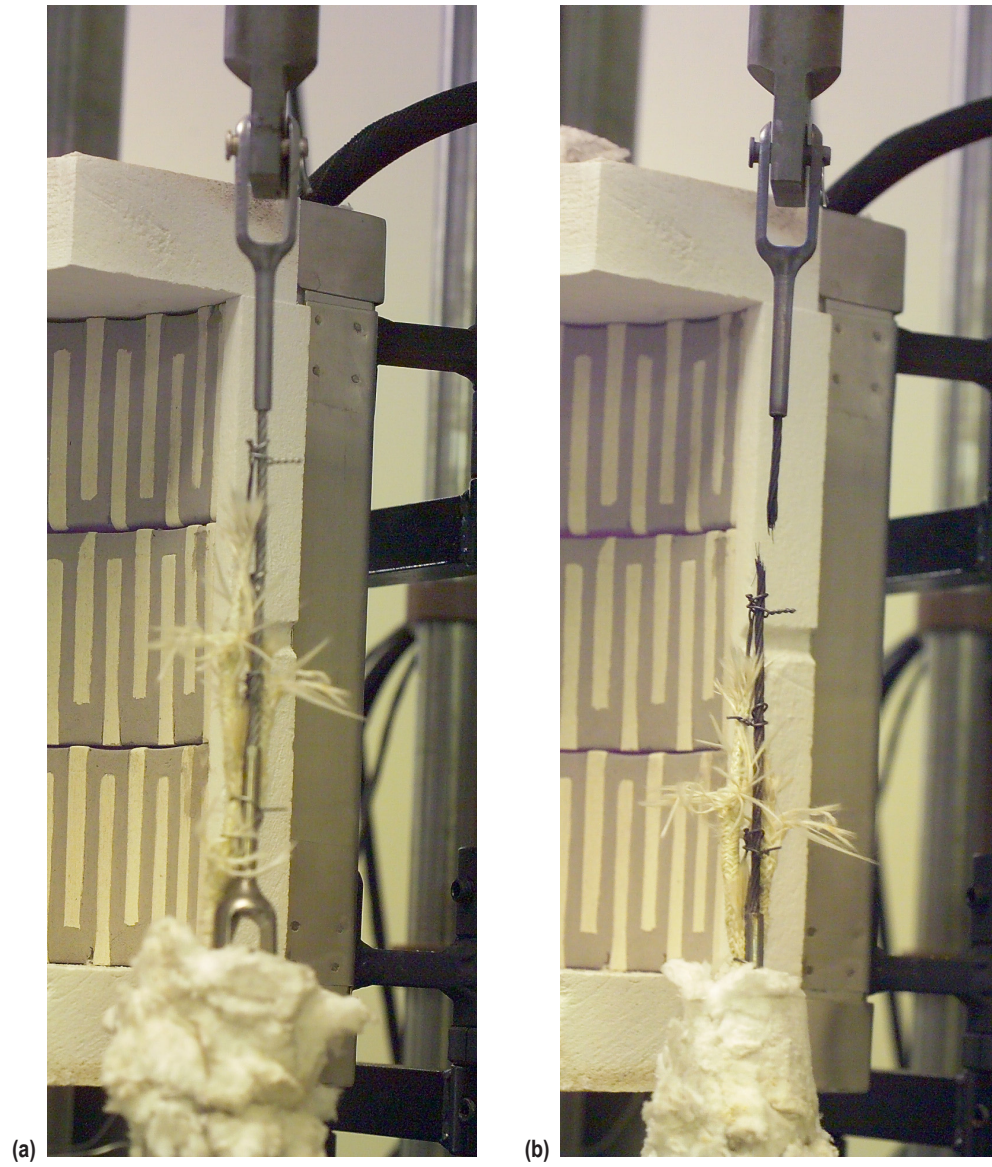


Figure 12. 071081–ELV–10 (a) before testing and (b) after testing.

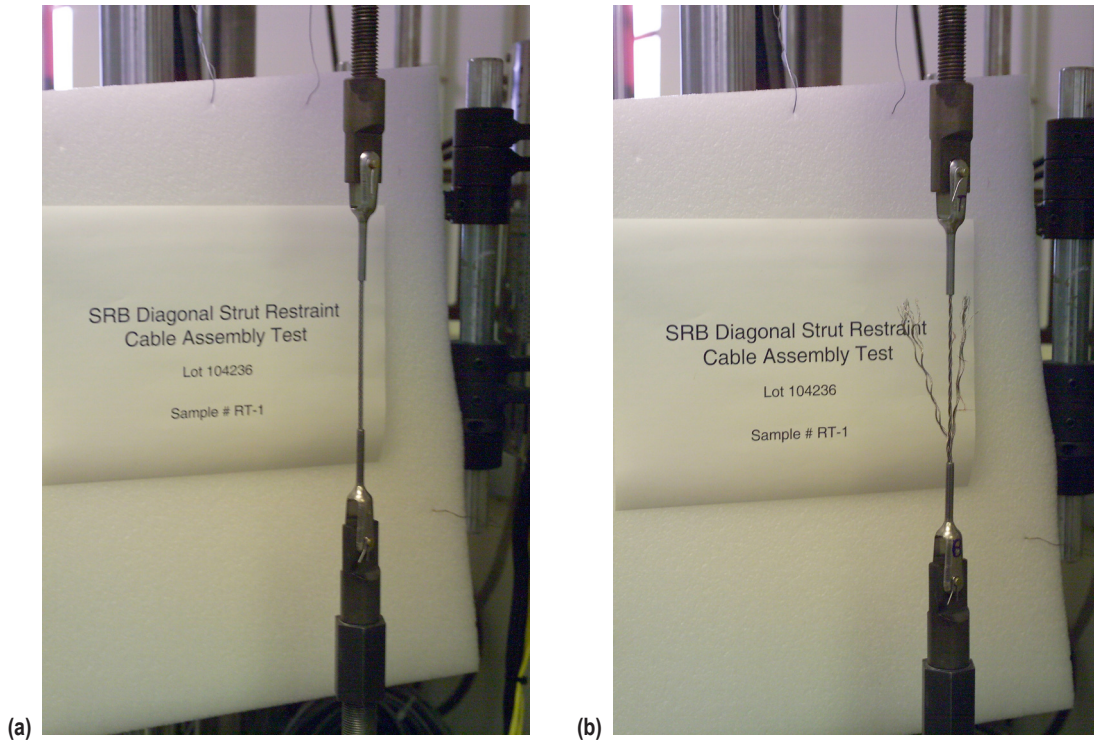


Figure 13. 104236–RT–1 (a) before testing and (b) after testing.

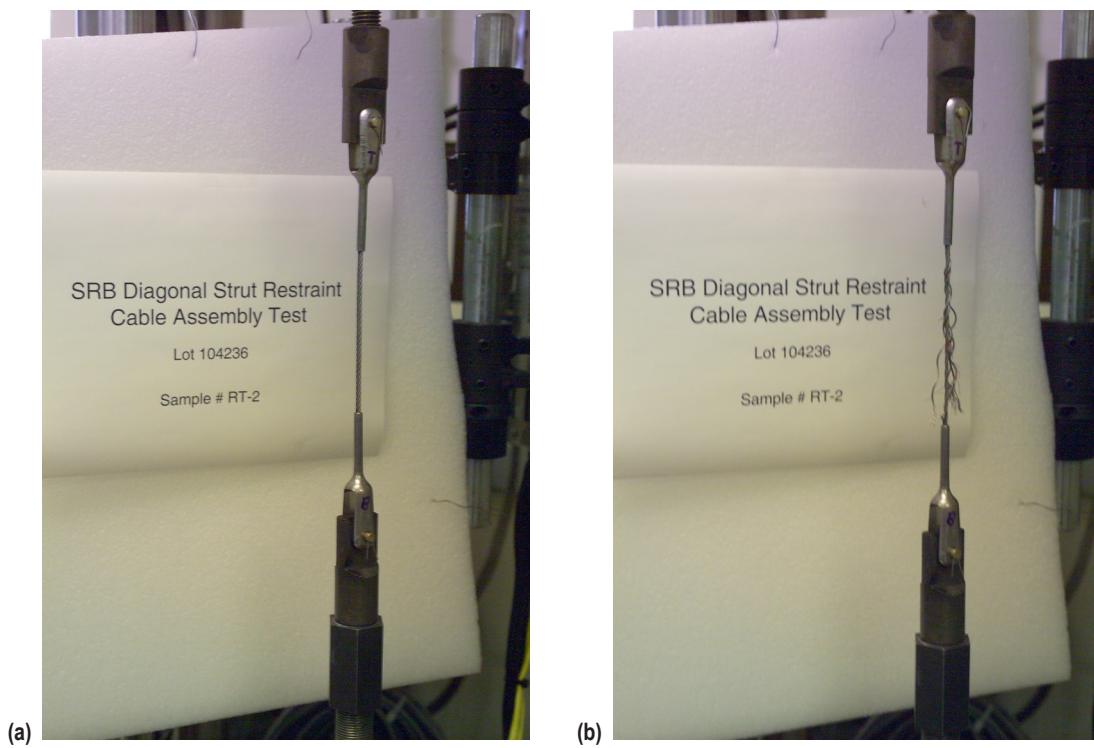


Figure 14. 104236–RT–2 (a) before testing and (b) after testing.

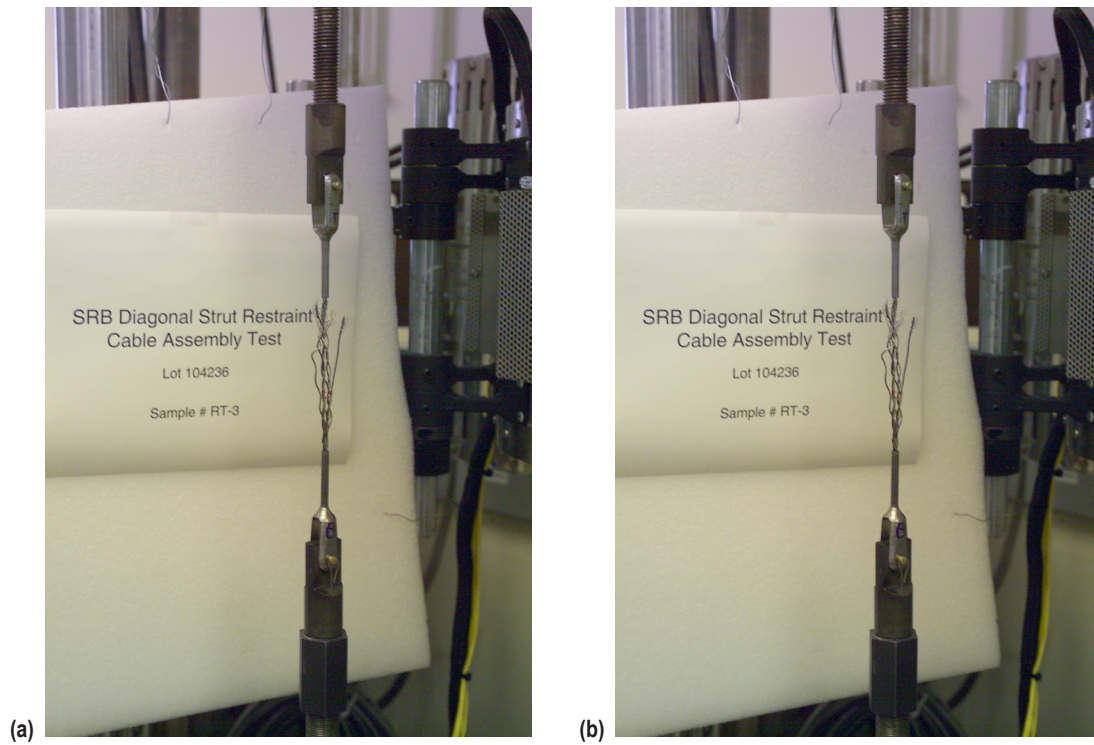


Figure 15. 104236–RT–3 (a) before testing and (b) after testing.

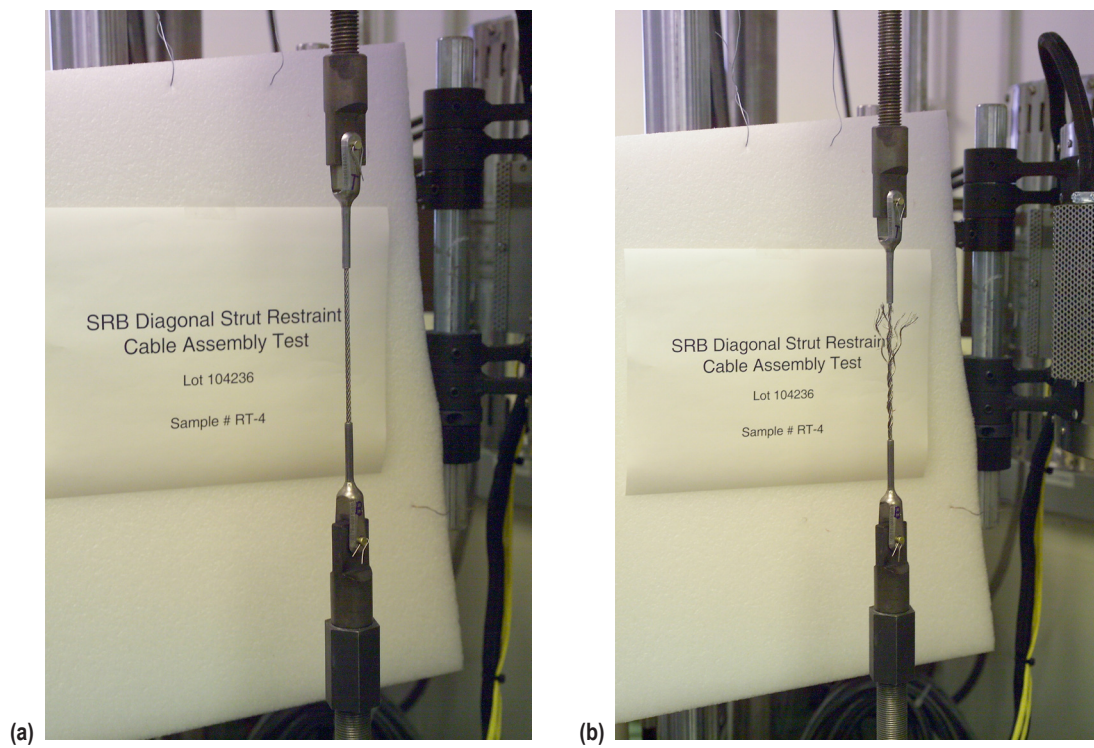


Figure 16. 104236–RT–4 (a) before testing and (b) after testing.

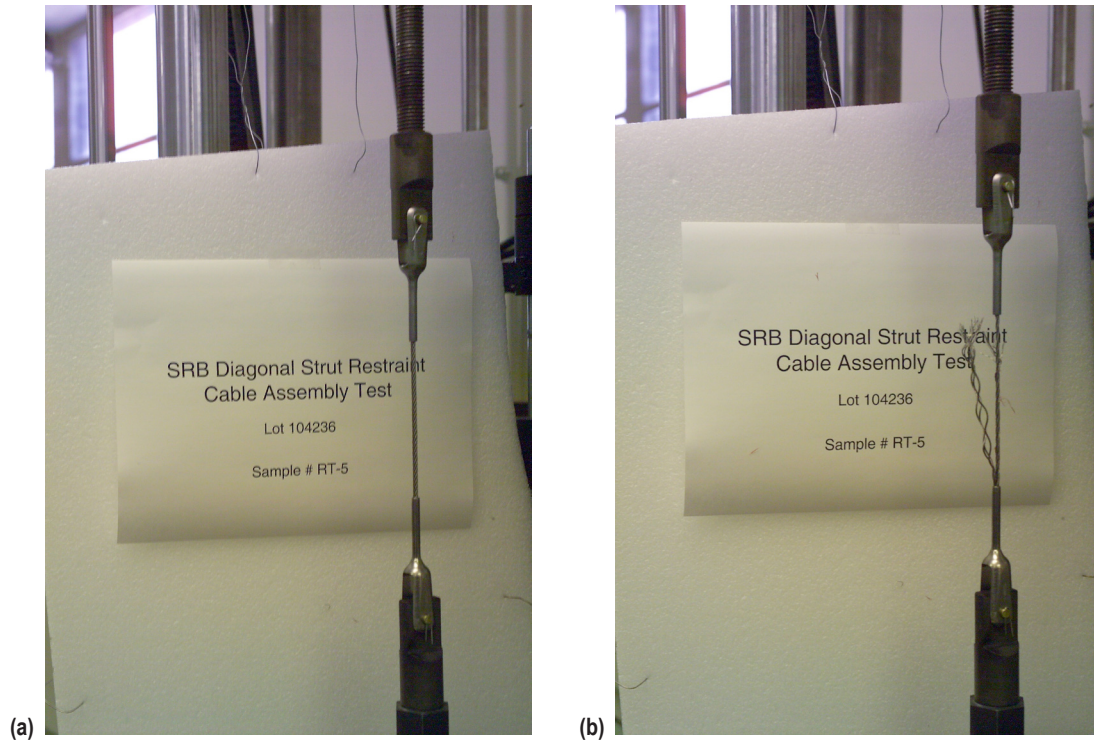


Figure 17. 104236–RT–5 (a) before testing and (b) after testing.

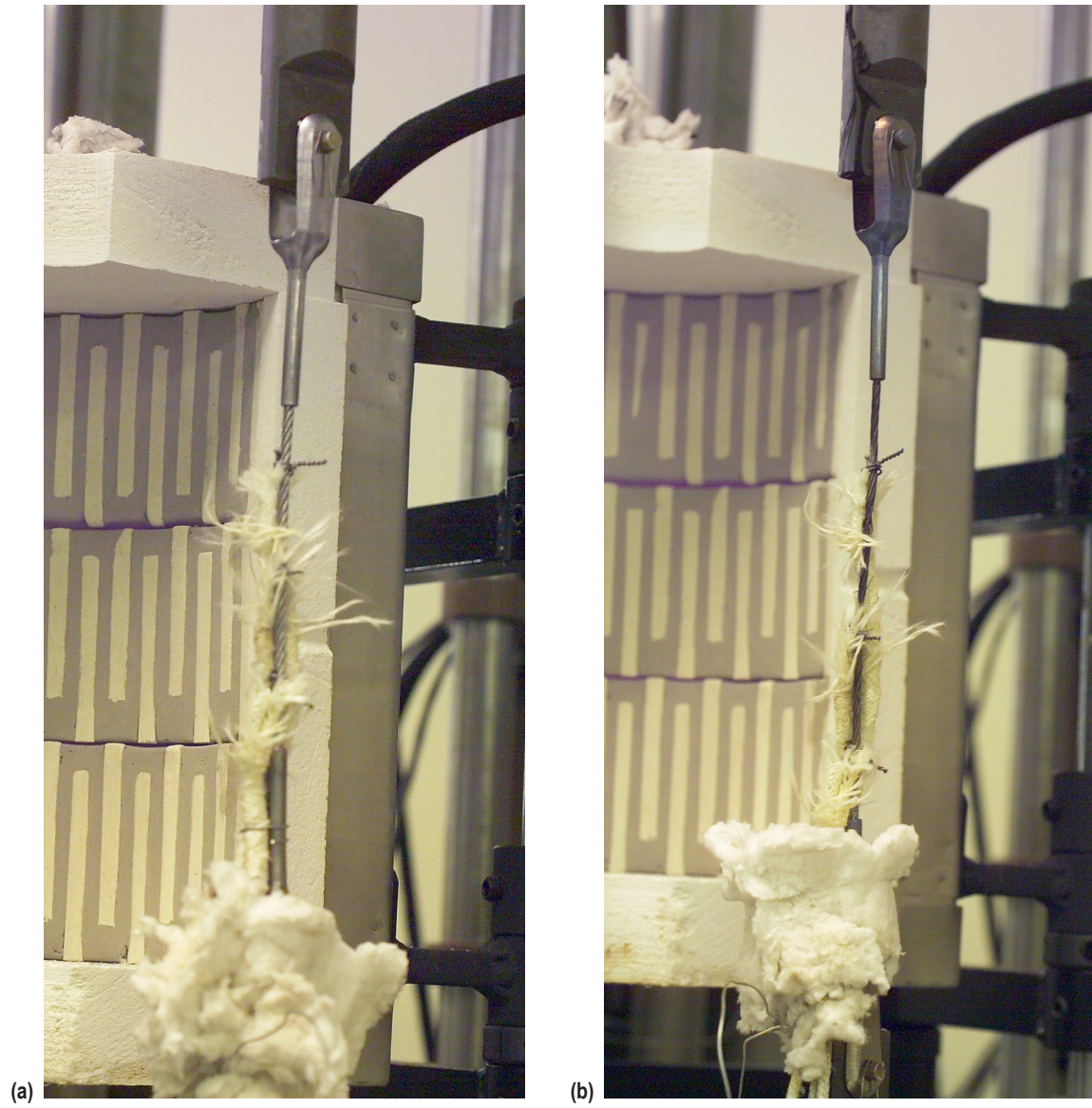


Figure 18. 104236–ELV–6 (a) before testing and (b) after testing.

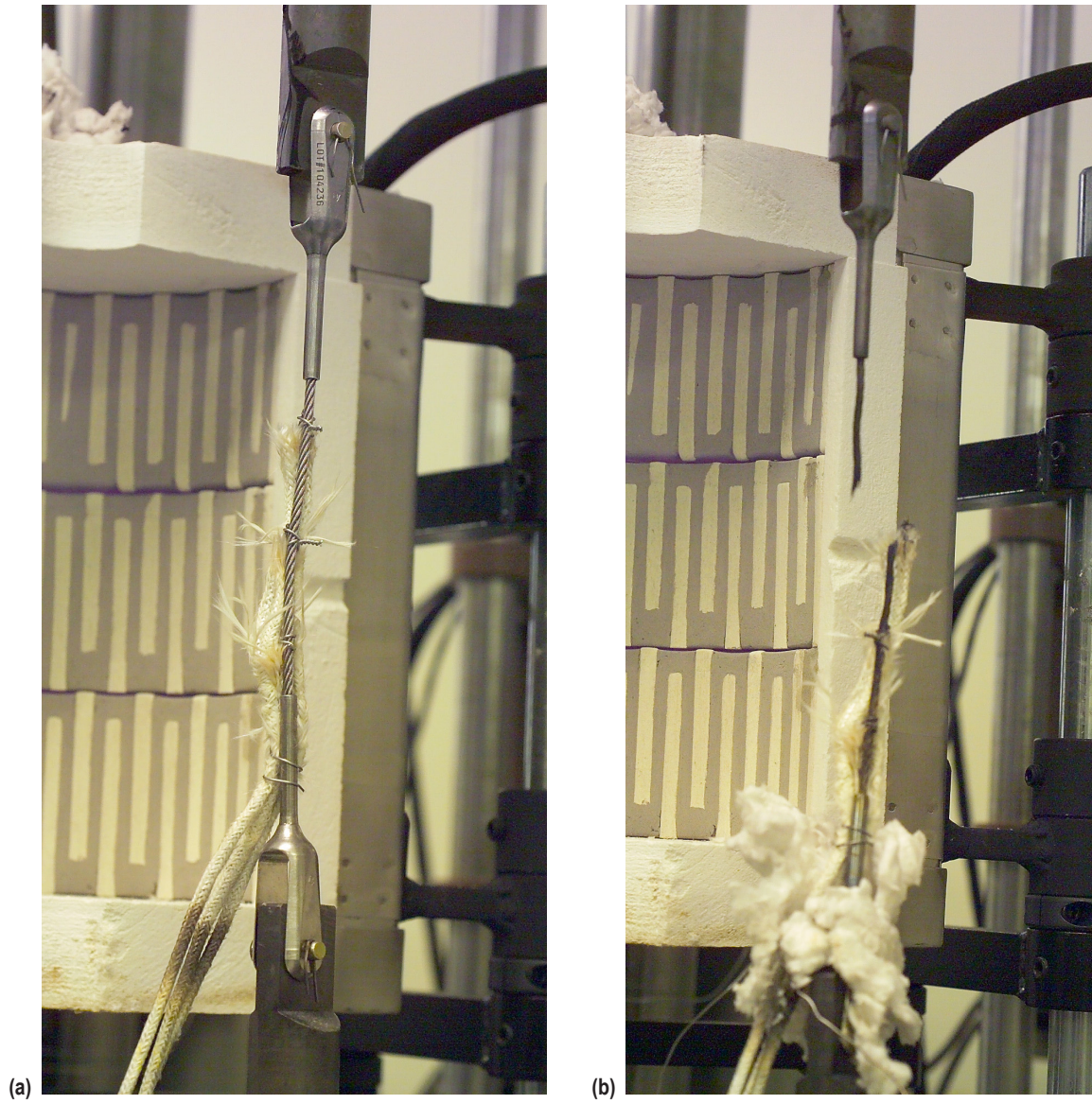


Figure 19. 104236-ELV-7 (a) before testing and (b) after testing.

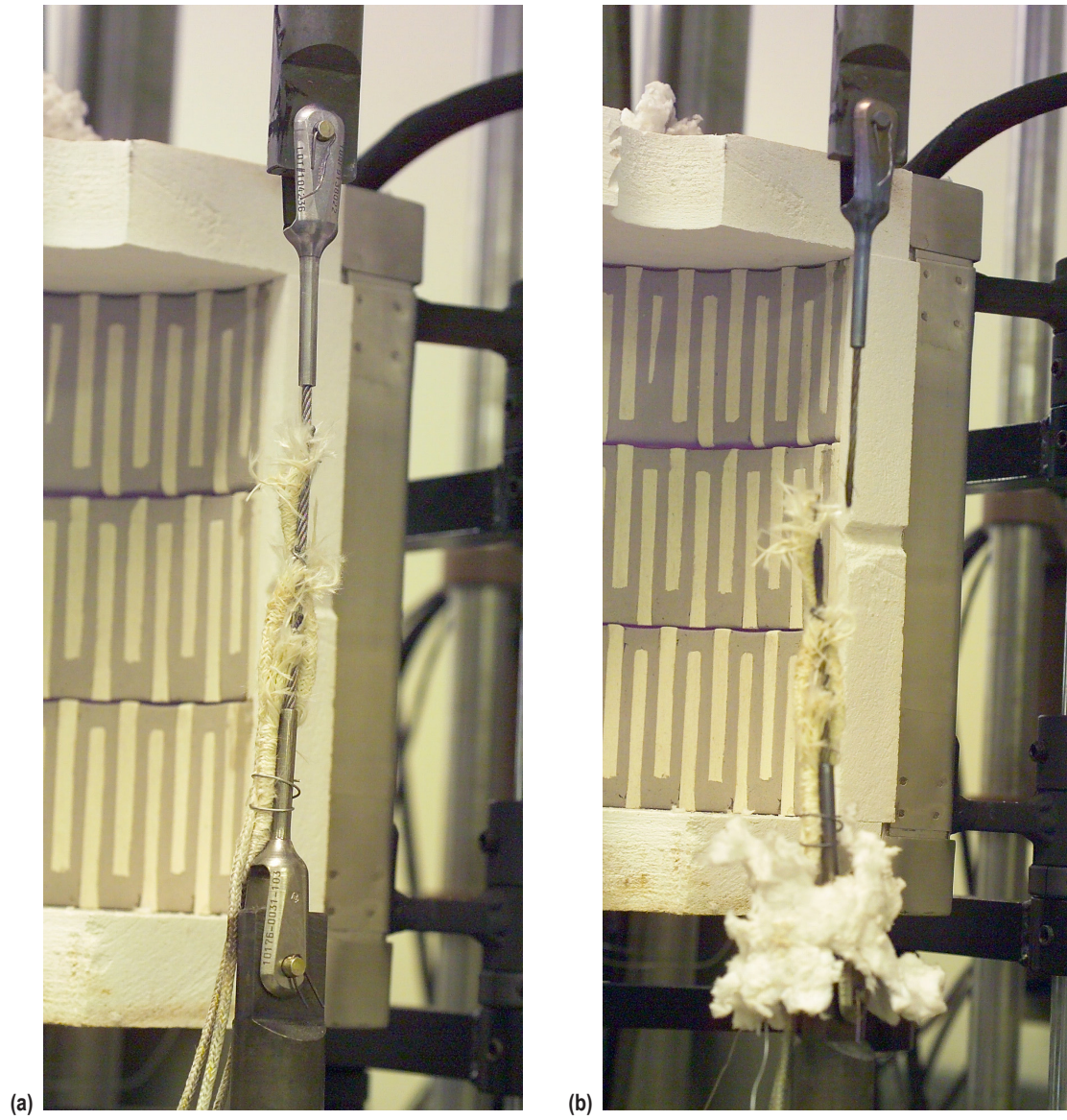


Figure 20. 104236–ELV–8 (a) before testing and (b) after testing.

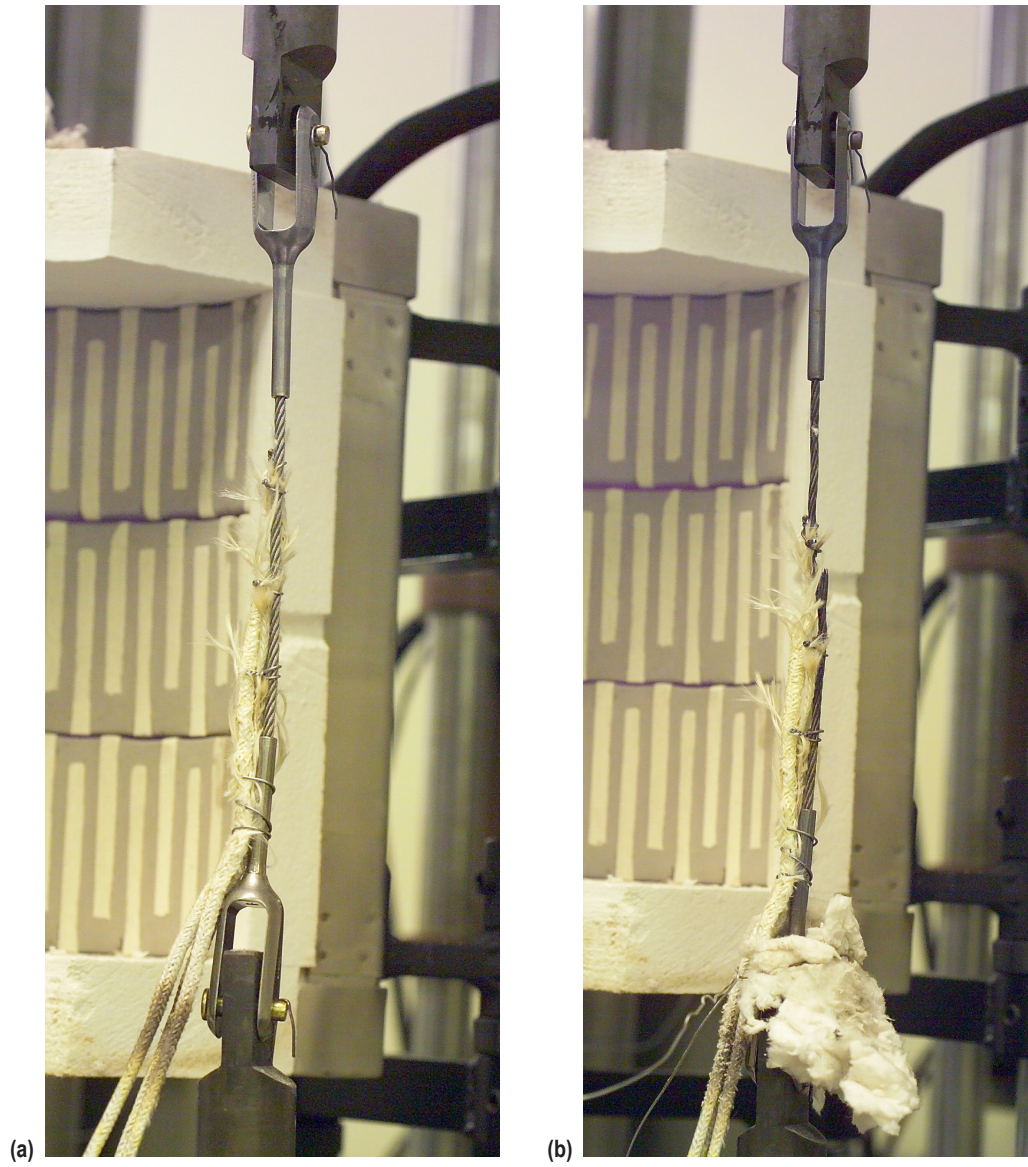


Figure 21. 104236–ELV–9 (a) before testing and (b) after testing.

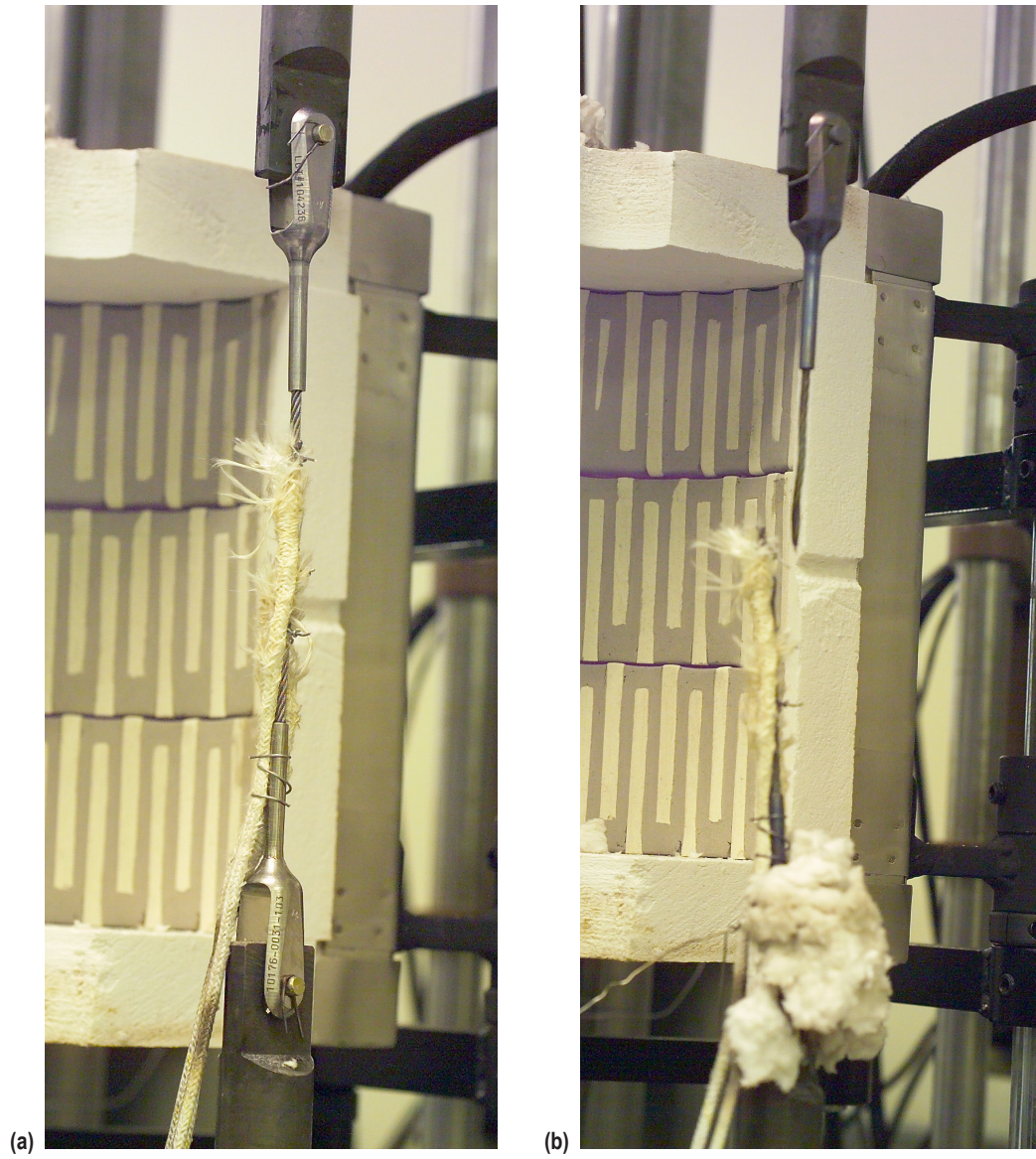


Figure 22. 104236–ELV–10 (a) before testing and (b) after testing.

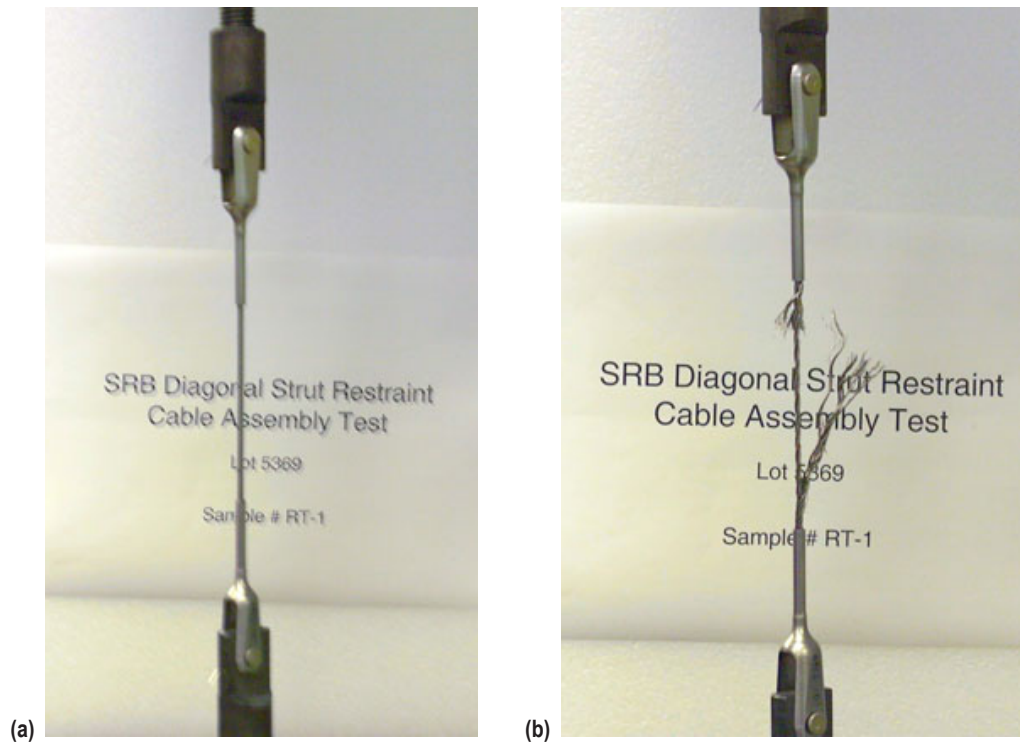


Figure 23. 5369–RT–1 (a) before testing and (b) after testing.

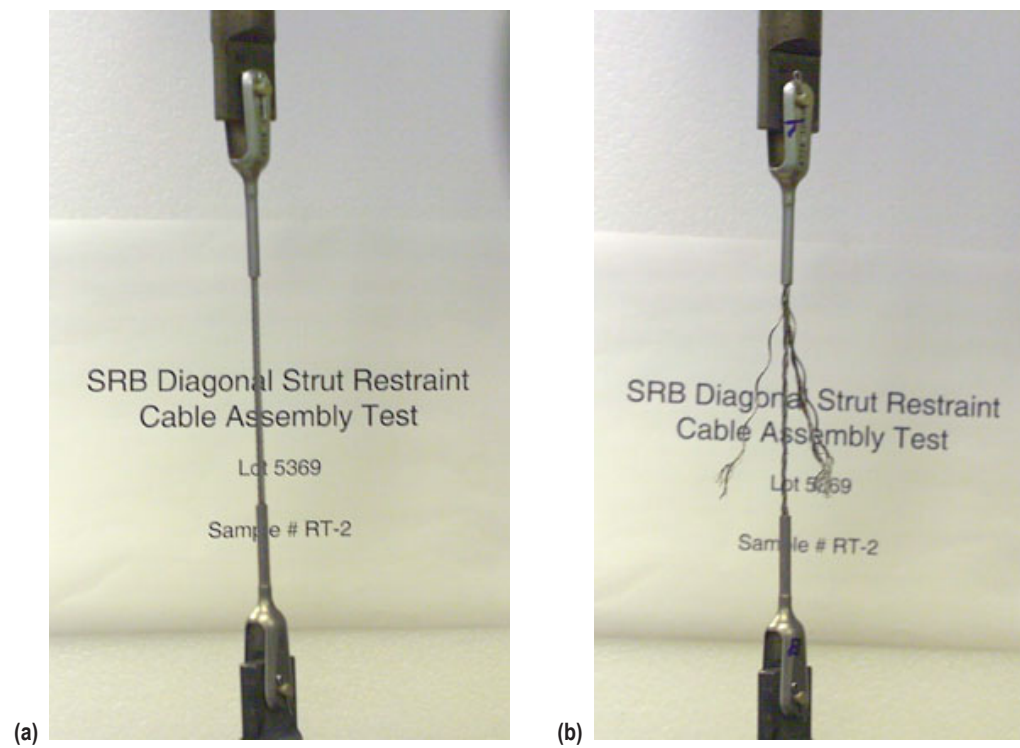


Figure 24. 5369–RT–2 (a) before testing and (b) after testing.

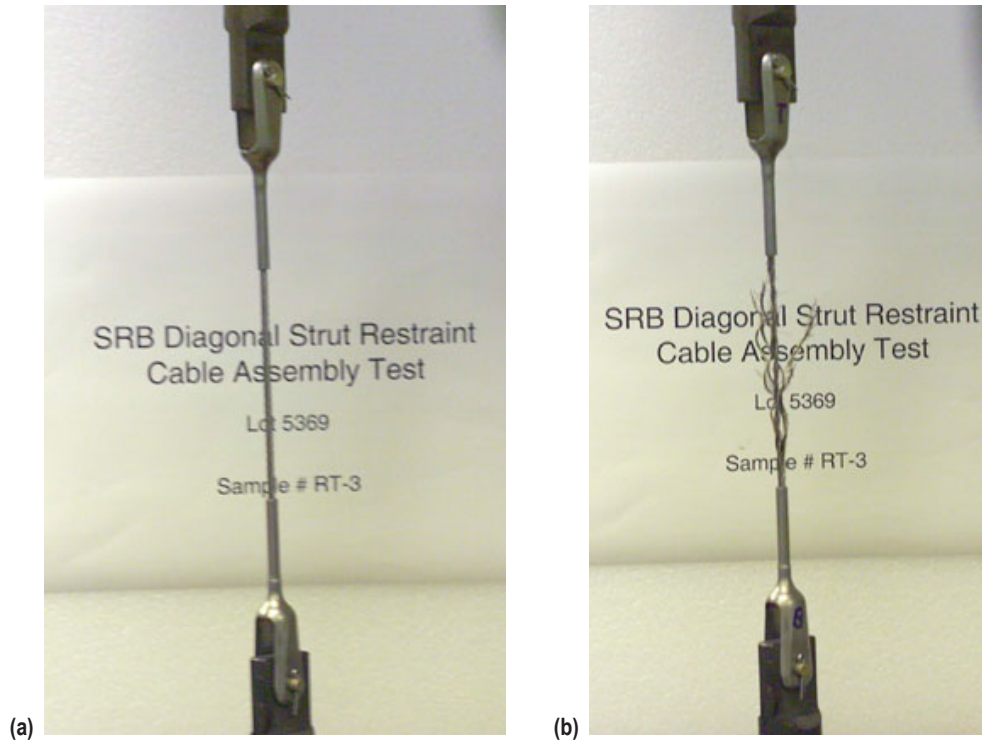


Figure 25. 5369–RT–3 (a) before testing and (b) after testing.

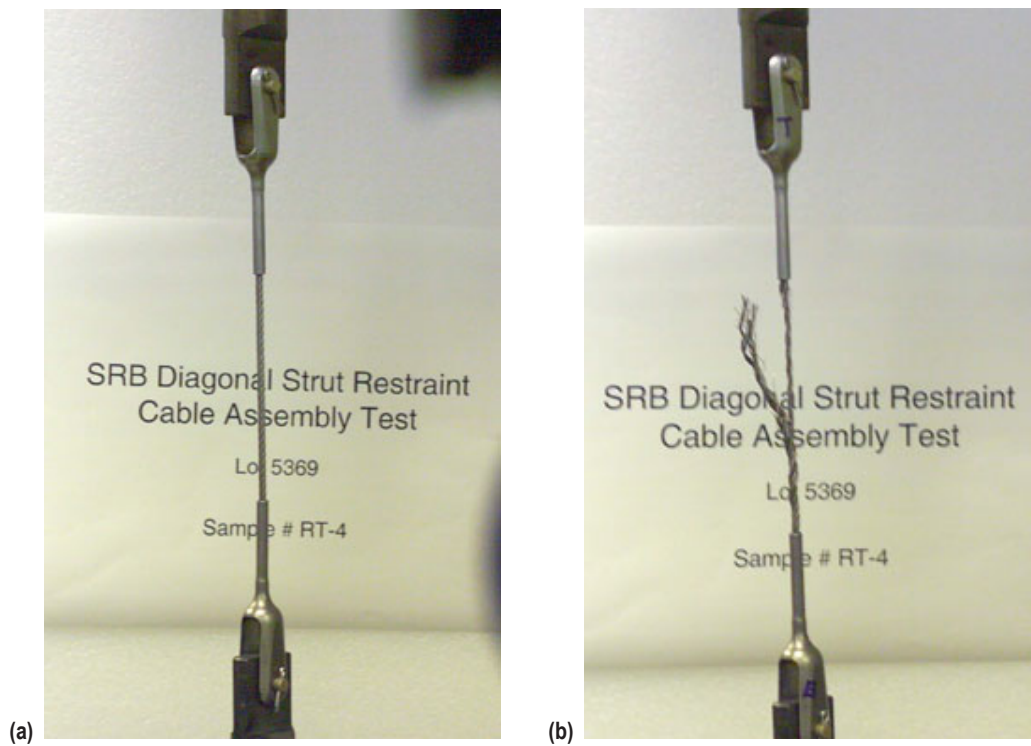


Figure 26. 5369–RT–4 (a) before testing and (b) after testing.

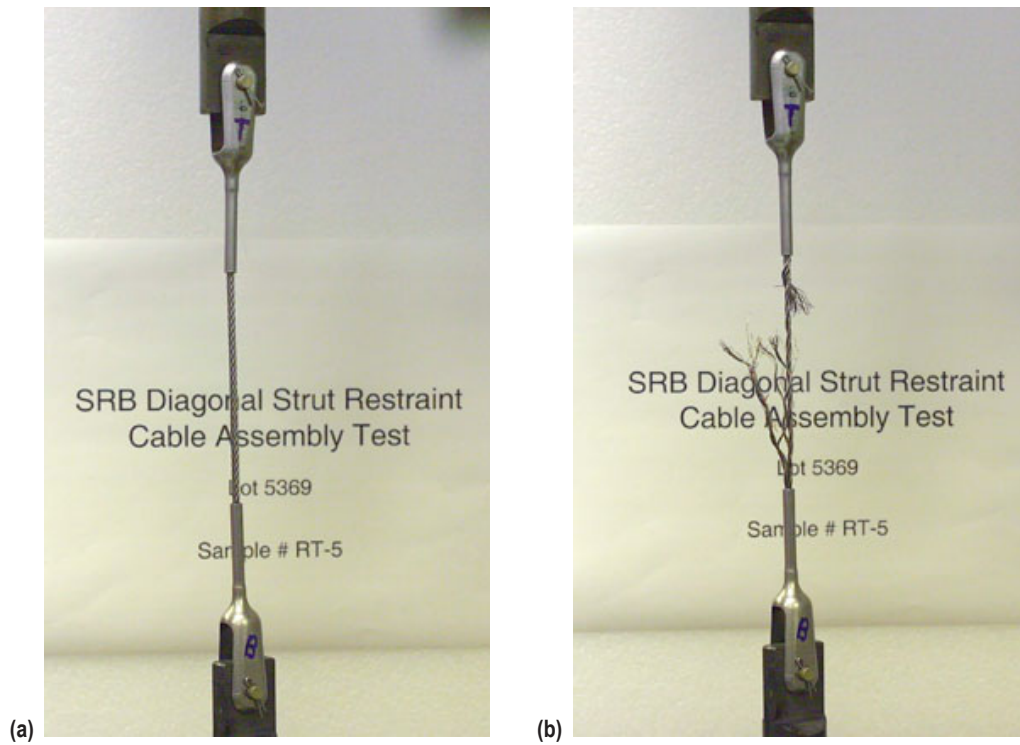


Figure 27. 5369-RT-5 (a) before testing and (b) after testing.



Figure 28. 5369-ELV-6 (a) before testing and (b) after testing.



Figure 29. 5369–ELV–7 (a) before testing and (b) after testing.



Figure 30. 5369–ELV–8 (a) before testing and (b) after testing.



Figure 31. 5369–ELV–9 (a) before testing and (b) after testing.



Figure 32. 5369–ELV–10 (a) before testing and (b) after testing.

APPENDIX B—PROCEDURE CHECKLISTS

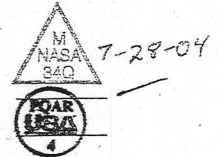
Attachment 1

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
	Date: 7/26/04	Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

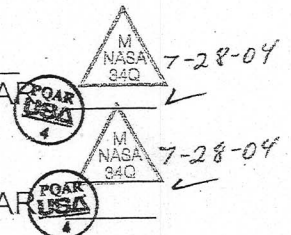
Verify PQAR



6.0.2 Note serial number or other identification for the Restraint Cable in test:

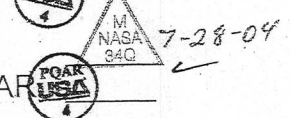
Lot 5369 RT-1

Verify PQAR



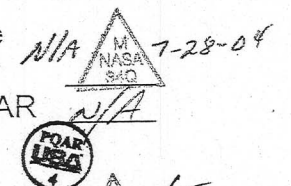
6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

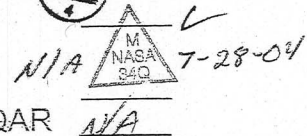
Verify PQAR



6.0.5 Photograph set-up.

X 6.0.6 Install furnace and heat to 1250F (HT tests only).

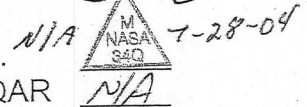
Verify PQAR



6.0.7 Begin video.

X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

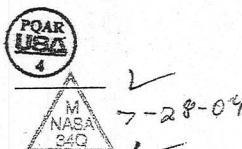
Verify PQAR



6.0.9 Document temperature of test article.

73°F

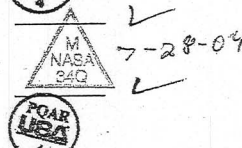
Witness PQAR



6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

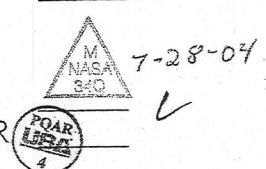
42.4 lbs

Witness PQAR



6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



6.0.12 Continue increase load until failure occurs.:

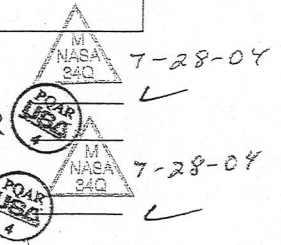
Witness PQAR



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



6.0.14 Stop video.

6.0.15 Document load and location of failure:

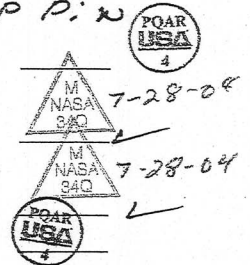
Failure load 1726.7

Failure location:

N/A swage
4" - Top inches from cable end
N/A other

*Center Line
Top Pin*

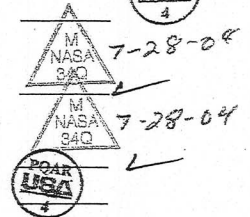
Verify PQAR



6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



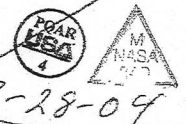
6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmänn (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



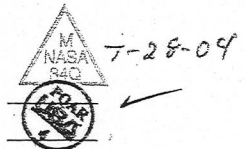
Attachment #2

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

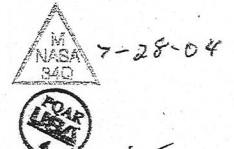
Verify PQAR



6.0.2 Note serial number or other identification for the Restraint Cable in test:

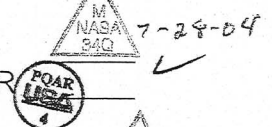
Lot 5369 RT-2

Verify PQAR



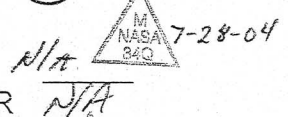
6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



X6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

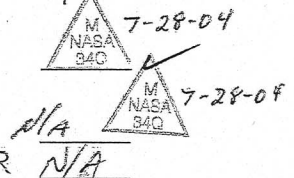
Verify PQAR



6.0.5 Photograph set-up.

X6.0.6 Install furnace and heat to 1250F (HT tests only).

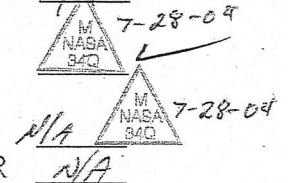
Verify PQAR



6.0.7 Begin video.

X6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



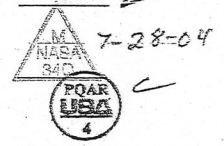
6.0.9 Document temperature of test article. 720 F

Witness PQAR



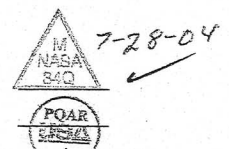
6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 41.1

Witness PQAR



6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



6.0.12 Continue increase load until failure occurs.:

Witness PQAR



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6.0.13 Verify load and instrumentation.

Verify PQAR



7-28-04

6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 1781.9

Failure location:

N/A
7 3/4 - T
N/A

swage

inches from cable end

other

Verify PQAR



7-28-04

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



7-28-04

7-28-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochenmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



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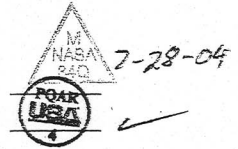
Attachment #3

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

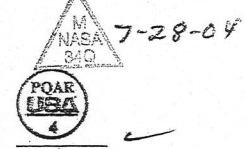
Verify PQAR



6.0.2 Note serial number or other identification for the Restraint Cable in test:

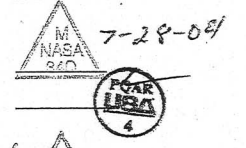
Lot 5369 RT-3

Verify PQAR



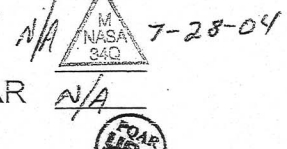
6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR

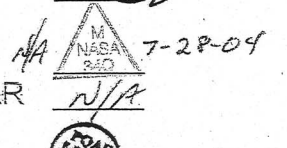


6.0.5 Photograph set-up.

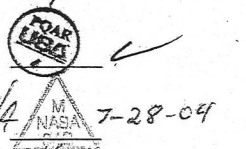


X 6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR

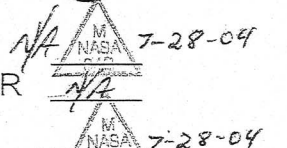


6.0.7 Begin video.



X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

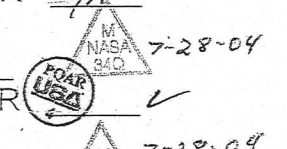
Verify PQAR



6.0.9 Document temperature of test article.

720F

Witness PQAR



6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

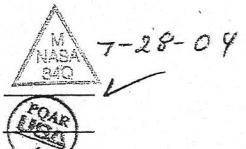
41.1 lbs

Witness PQAR



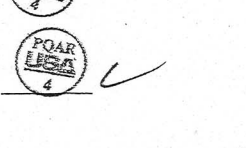
6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



6.0.12 Continue increase load until failure occurs.:

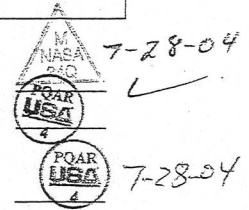
Witness PQAR



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6.0.13 Verify load and instrumentation.

Verify PQAR



6.0.14 Stop video.

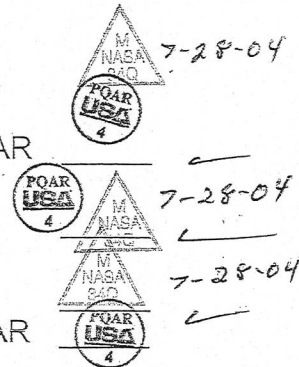
6.0.15 Document load and location of failure:

Failure load 1797.7

Failure location:

N/A swage
3 1/2 - T inches from cable end
N/A other

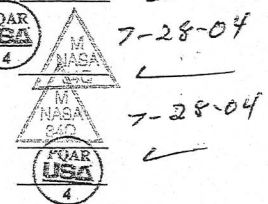
Verify PQAR



6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



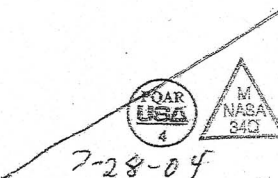
6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



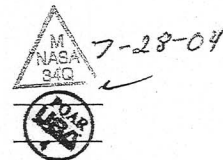
Attachment 4

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064 Date: 7/26/04	Revision: Basic Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

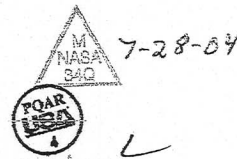
Verify PQAR



6.0.2 Note serial number or other identification for the Restraint Cable in test:

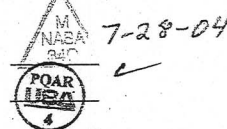
Lot 5369 RT-4

Verify PQAR



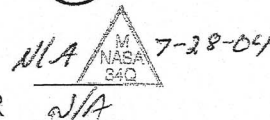
6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR

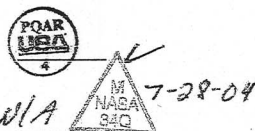


X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



6.0.5 Photograph set-up.



X 6.0.6 Install furnace and heat to 1250F (HT tests only).

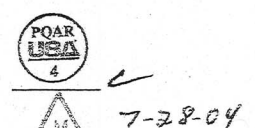
Verify PQAR



6.0.7 Begin video.

X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



6.0.9 Document temperature of test article. 720 F

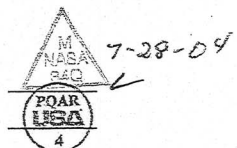
Witness PQAR



6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

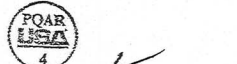
44.2 lbs

Witness PQAR



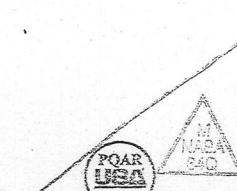
6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



6.0.12 Continue increase load until failure occurs.

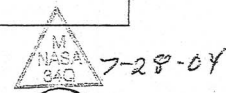
Witness PQAR



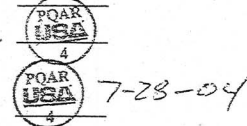
ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR.



6.0.14 Stop video.



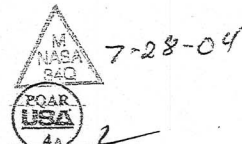
6.0.15 Document load and location of failure:

Failure load 1792.5

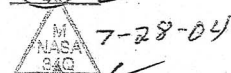
Failure location:

N/A swage
3/4-T inches from cable end
N/A other

Verify PQAR

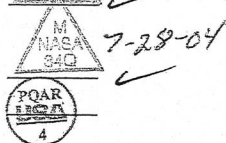


6.0.16 Photograph set-up.



6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochenmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



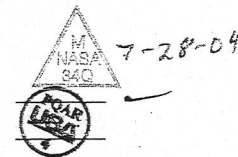
Attachment #5

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064 Date: 7/26/04	Revision: Basic Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

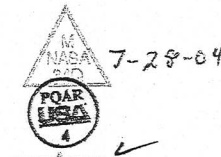
Verify PQAR



6.0.2 Note serial number or other identification for the Restraint Cable in test:

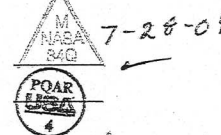
Lot 5369 RT-5

Verify PQAR



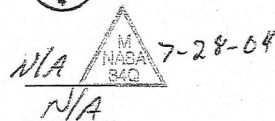
6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR

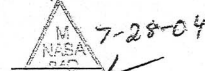


X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



6.0.5 Photograph set-up.



X 6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



6.0.7 Begin video.



X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



6.0.9 Document temperature of test article. 710 F

Witness PQAR



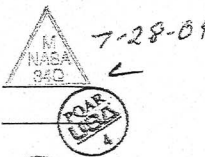
6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 41.5

Witness PQAR



6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



6.0.12 Continue increase load until failure occurs.:

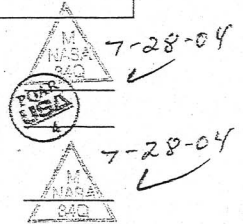
Witness PQAR



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



6.0.14 Stop video.

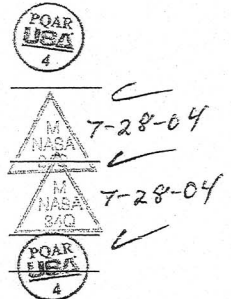
6.0.15 Document load and location of failure:

Failure load 1779.8

Failure location:

N/A swage
44-T inches from cable end
N/A other

Verify PQAR



6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR

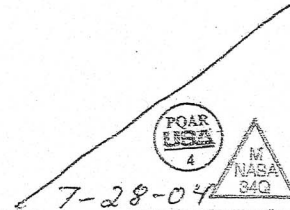
6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochemann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



Attachment #6

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064 Date: 7/26/04	Revision: Basic Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR

6.0.2 Note serial number or other identification for the Restraint Cable in test:

Lot 5369 EIV-6

Verify PQAR

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR

6.0.5 Photograph set-up.

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR

6.0.7 Begin video.

N/A  7-28-04

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR

6.0.9 Document temperature of test article.

1258

Witness PQAR

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

45.1 lbs

Witness PQAR

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR

6.0.12 Continue increase load until failure occurs.

Witness PQAR

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation. *

Verify PQAR ☐

6.0.14 Stop video. ☐

6.0.15 Document load and location of failure: *

Failure load

Failure location:

5 3/4 - T swage
inches from cable end
other

Verify PQAR ☐

6.0.16 Photograph set-up. ☒

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. ☒

Verify PQAR ☐

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knocheimann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

*Changed Load Rate from 0.02 IN/min.
to 0.2 IN/min.*

198.8 lbs. max at 0.2 IN/min.

*302.2 lbs. Impact Load to Break
Sample.*

*Machine piston out of
Range.*

Attachment #17

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



7-28-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

Lot 5369 FIV-7

Verify PQAR



7-28-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



7-28-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



7-28-04

6.0.5 Photograph set-up.

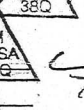
Verify PQAR



7-28-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



7-28-04

X6.0.7 Begin video.

Verify PQAR



7-28-04

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

6.0.9 Document temperature of test article.

1259

Witness PQAR



7-28-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

41.5 lbs

Witness PQAR



7-28-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



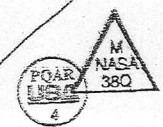
7-28-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR





7-28-04



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR   7-28-04 ✓
N/A

X 6.0.14 Stop video.



6.0.15 Document load and location of failure:

Failure load 349.1

Failure location:

N/A swage
5"-T inches from cable end
N/A other



NOTE: LOAD RATE
0.8 in/min
PER TELECON

Verify PQAR   7-28-04 ✓

6.0.16 Photograph set-up.

  7-28-04 ✓

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR   7-28-04 ✓

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochenmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

  7-28-04 ✓



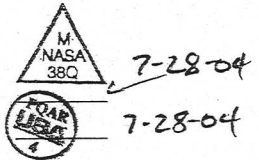
Attachment # 8

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

- 6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

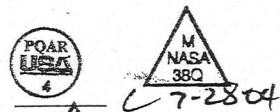
Verify PQAR



- 6.0.2 Note serial number or other identification for the Restraint Cable in test:

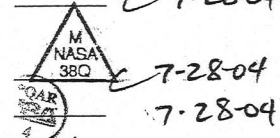
Lot 5369 Elv-8

Verify PQAR



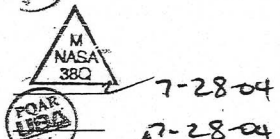
- 6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



- 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

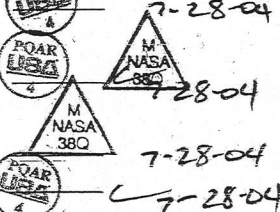
Verify PQAR



- 6.0.5 Photograph set-up.

- 6.0.6 Install furnace and heat to 1250F (HT tests only).

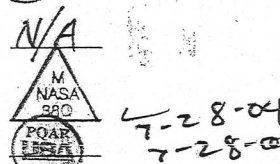
Verify PQAR



- X 6.0.7 Begin video.

- 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



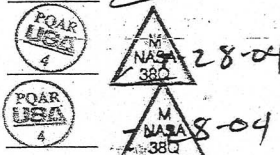
- 6.0.9 Document temperature of test article. 1258 °F

Witness PQAR



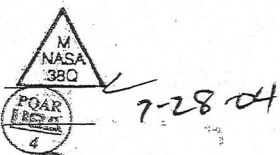
- 6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 43.1/65

Witness PQAR



- 6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



- 6.0.12 Continue increase load until failure occurs.:

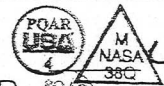
Witness PQAR



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



7-28-04

X6.0.14 Stop video.



7-28-04

6.0.15 Document load and location of failure:

Failure load 323.0

Failure location:

N/A swage
5 3/8" - T inches from cable end
N/A other

Note: Load Rate

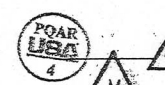
2.8 in/min
Per Telecon

Verify PQAR



7-28-04

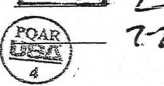
6.0.16 Photograph set-up.



7-28-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



7-28-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochemann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



7-28-04

Attachment 9

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064 Date: 7/26/04	Revision: Basic Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

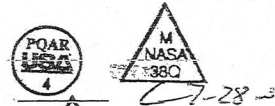
Verify PQAR



6.0.2 Note serial number or other identification for the Restraint Cable in test:

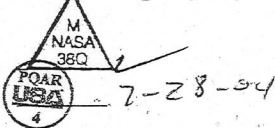
Lot 5369 E1v-9

Verify PQAR



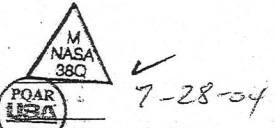
6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



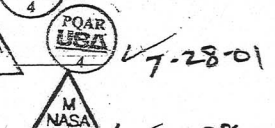
6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



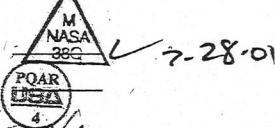
6.0.5 Photograph set-up.

Verify PQAR



6.0.6 Install furnace and heat to 1250F (HT tests only).

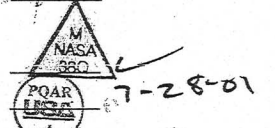
Verify PQAR



X6.0.7 Begin video.

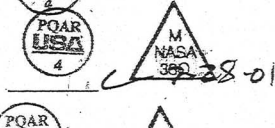
6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



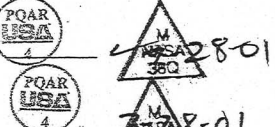
6.0.9 Document temperature of test article. 1254°

Witness PQAR



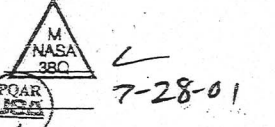
6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 43.8

Witness PQAR



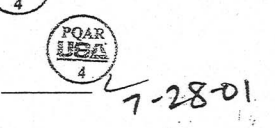
6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



6.0.12 Continue increase load until failure occurs.:

Witness PQAR



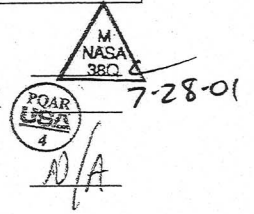
7-28-04



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



X6.0.14 Stop video.

6.0.15 Document load and location of failure:

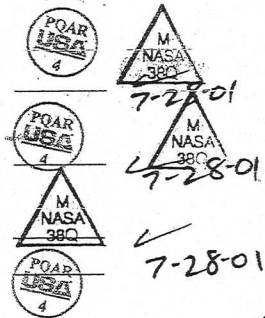
Failure load 330.3

Failure location:

N/A swage
6 1/4 - T inches from cable end
N/A other

*Note: Load Rate
0.8 in/min Per Telecon*

Verify PQAR



6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR

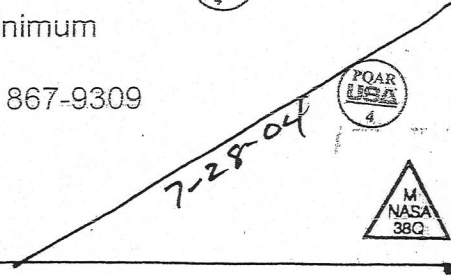
6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



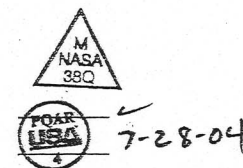
Attachment 10

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

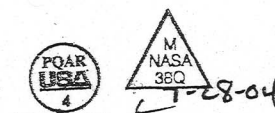
Verify PQAR



6.0.2 Note serial number or other identification for the Restraint Cable in test:

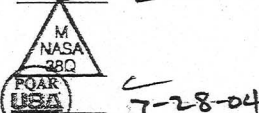
Lot 5369 Elr-10

Verify PQAR



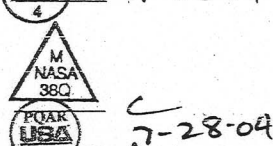
6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR

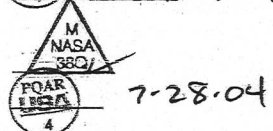


6.0.5 Photograph set-up.



6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR

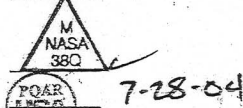


X6.0.7 Begin video.

NA 7

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



6.0.9 Document temperature of test article.

1254

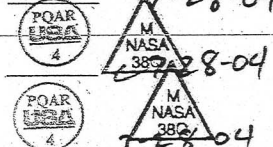
Witness PQAR



6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

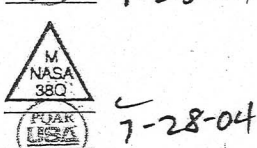
43.8

Witness PQAR



6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



6.0.12 Continue increase load until failure occurs.:

Witness PQAR



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



7-28-04

X6.0.14 Stop video.

NA

6.0.15 Document load and location of failure:

Failure load 337.8

Failure location:

5 3/4 - T

swage

inches from cable end

other

Verify PQAR



7-28-04



7-28-04



7-28-04



7-28-04

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



7-28-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochemann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



7-28-04

Note: Load Rate
0.8 in/min per Telecom

Attachment #1

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

Lot 071081 RT-1

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



6.0.5 Photograph set-up.



8-6-04

*6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



6.0.7 Begin video.



8-6-04

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



6.0.9 Document temperature of test article.

70°F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

46 lbs

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04



8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 1956.8

Failure location:

2 1/8" - T swage
inches from cable end
2 1/8" - T other

Verify PQAR



8-6-04



8-6-04

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



✓



8-6-04



6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochemann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

Attachment #2

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

Lot 071081 RT-2

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

6.0.5 Photograph set-up.



8-6-04

*6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

6.0.7 Begin video.



8-6-04

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04

6.0.9 Document temperature of test article.

70% F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04

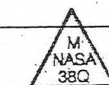


8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

6.0.14 Stop video.



8-6-04

6.0.15 Document load and location of failure:

Failure load 1954.4

Failure location:

N/A swage
3 3/4" - T inches from cable end
N/A other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



















8-6-04

ATTACHMENT # 3

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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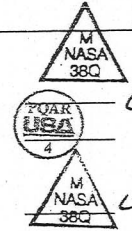
6.0 TEST OPERATION

- 6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures
Verify PQAR   8-6-04
- 6.0.2 Note serial number or other identification for the Restraint Cable in test:
LOT 071081 RT-3
Verify PQAR  8-6-04
- 6.0.3 Mount the Restraint Cable into the fixture.
Verify PQAR   8-6-04
- *6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.
Verify PQAR  8-6-04
- 6.0.5 Photograph set-up.
 8-6-04
- *6.0.6 Install furnace and heat to 1250F (HT tests only).
Verify PQAR  8-6-04
- 6.0.7 Begin video.
 8-6-04
- *6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).
Verify PQAR  8-6-04
- 6.0.9 Document temperature of test article. 710F
Witness PQAR  8-6-04
- 6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.
Witness PQAR   8-6-04
- 6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.
47.6 lbs
Verify PQAR   8-6-04
- 6.0.12 Continue increase load until failure occurs.:
Witness PQAR  8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
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6.0.13 Verify load and instrumentation.

Verify PQAR



6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 1891.5 (1953.3) second Peak Load

Failure location:

N/A swage
3 3/4" - T inches from cable end
N/A other

Verify PQAR



6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochemann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

- 6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

- 6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT ~~071081~~ RT-4

Verify PQAR



8-6-04

- 6.0.3 Mount the Restraint Cable into the fixture.

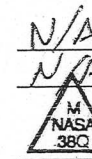
Verify PQAR



8-6-04

- *6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

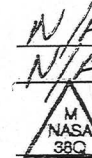
- 6.0.5 Photograph set-up.



8-6-04

- *6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

- 6.0.7 Begin video.



8-6-04

- *6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR



8-6-04

- 6.0.9 Document temperature of test article.

709F

Witness PQAR



8-6-04

- 6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

- 6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

44.7 lbs

Verify PQAR



8-6-04

- 6.0.12 Continue increase load until failure occurs.:

Witness PQAR





8-6-04




8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR   8-6-04

6.0.14 Stop video.

 8-6-04

6.0.15 Document load and location of failure:

Failure load 1905.6

Failure location:


Inside Top swage

N/A inches from cable end



N/A other

Verify PQAR  8-6-04

6.0.16 Photograph set-up.

 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR   8-6-04



6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346














 

8-6-04

Attachment # 5

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

- 6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures
Verify PQAR  8-6-04 
- 6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 071081 RT-5
Verify PQAR  8-6-04
- 6.0.3 Mount the Restraint Cable into the fixture.
Verify PQAR  8-6-04 
- * 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.
Verify PQAR N/A 8-6-04 N/A
- 6.0.5 Photograph set-up.
 8-6-04
- * 6.0.6 Install furnace and heat to 1250F (HT tests only).
Verify PQAR N/A 8-6-04 N/A
- 6.0.7 Begin video.
 8-6-04
- * 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):
Verify PQAR N/A 8-6-04 N/A
- 6.0.9 Document temperature of test article. 710 F
Witness PQAR  8-6-04
- 6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.
Witness PQAR  8-6-04  8-6-04
- 6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.9 lbs
Verify PQAR  8-6-04  8-6-04
- 6.0.12 Continue increase load until failure occurs.:
Witness PQAR  8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR  8-6-04

6.0.14 Stop video.

 8-6-04

6.0.15 Document load and location of failure:


Failure load 1939.8

Failure location:

Inside Top swage
N/A inches from cable end
N/A other

Verify PQAR  8-6-04

6.0.16 Photograph set-up.

 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR  8-6-04



6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

  8-6-04

Attachment #6

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 071081 E16-6

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

6.0.5 Photograph set-up.



8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

*6.0.7 Begin video.

N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04

6.0.9 Document temperature of test article. 1251°F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

46.2 lbs

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR   8-6-04

N/A

* 6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 374.7


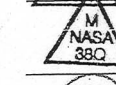

Failure location:

N/A swage
6.0"-7 inches from cable end
N/A other

Verify PQAR  8-6-04

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR    8-6-04


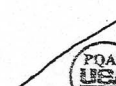
6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

  8-6-04

Attachment #7

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04



6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 071081 E1v-7

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04



6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04



6.0.5 Photograph set-up.

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04



~~6.0.7~~ Begin video.



6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04



6.0.9 Document temperature of test article.

1254°F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04



6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

43.0 lbs

Verify PQAR



8-6-04



6.0.12 Continue increase load until failure occurs.:

Witness PQAR



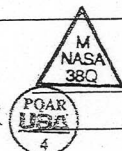
8-6-04



ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

* 6.0.14 Stop video.

N/A 8-6-04

6.0.15 Document load and location of failure:

Failure load 383.2

Failure location:

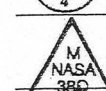
N/A swage
6.0" - T inches from cable end
N/A other

Verify PQAR



8-6-04

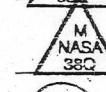
6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04



Attachment #8

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 071081 EIV-8

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

6.0.5 Photograph set-up.



8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

*6.0.7 Begin video.



8-6-04

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04

6.0.9 Document temperature of test article. 1250°F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 46 lbs

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04



8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

*6.0.14 Stop video.

N/A

6.0.15 Document load and location of failure:

Failure load 388.8 lbs

Failure location:

N/A
6.0" T
N/A

swage

inches from cable end

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

Attachment II 9

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 071081 EL-9

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

6.0.5 Photograph set-up.



8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

*6.0.7 Begin video.



6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04

6.0.9 Document temperature of test article. 1258 °F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04



8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

*6.0.14 Stop video.

N/A

6.0.15 Document load and location of failure:

Failure load 358.0

Failure location:

N/A
4 3/8" - 7"
N/A

swage

inches from cable end

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

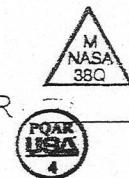
Attachment #10

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR

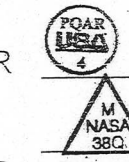


8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 071081 E/V-10

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

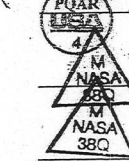
Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR

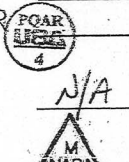


8-6-04

6.0.5 Photograph set-up.

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR

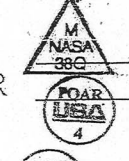


8-6-04

*6.0.7 Begin video.

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

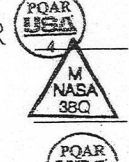
Verify PQAR



8-6-04

6.0.9 Document temperature of test article. 1240 F

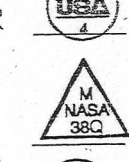
Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

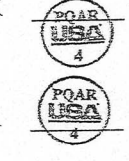
Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 43.5 lbs

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

*6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 361.3 lbs

Failure location:

N/A
4 1/8" - T
N/A

swage

inches from cable end

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

attachment # 1

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 RT-1

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR

N/A

8-6-04

6.0.5 Photograph set-up.



8-6-04

*6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR

N/A

8-6-04

6.0.7 Begin video.



8-6-04

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR

N/A

8-6-04

6.0.9 Document temperature of test article. 71 °F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.8 lbs

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04

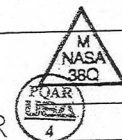


8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

6.0.14 Stop video.



8-6-04

6.0.15 Document load and location of failure:

Failure load 1900.3

Failure location:

Inside Top swage

N/A inches from cable end

N/A other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04



6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochenmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



















8-6-04

Attachment #2

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

- 6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures
Verify PQAR   8-6-04
- 6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 RT-2
Verify PQAR  8-6-0
- *6.0.3 Mount the Restraint Cable into the fixture.
Verify PQAR   8-6-0
- *6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.
Verify PQAR  8-6-0
- 6.0.5 Photograph set-up.
 8-6-0
- *6.0.6 Install furnace and heat to 1250F (HT tests only).
Verify PQAR  8-6-0
- 6.0.7 Begin video.
 8-6-04
- *6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):
Verify PQAR  8-6-04
- 6.0.9 Document temperature of test article. 71°F
Witness PQAR  8-6-04
- 6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.
Witness PQAR   8-6-0
- 6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.4 lbs
Verify PQAR   8-6-04
- 6.0.12 Continue increase load until failure occurs.:
Witness PQAR  8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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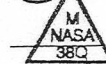
6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

6.0.14 Stop video.



8-6-04

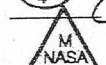
6.0.15 Document load and location of failure: Third Peak Load
Failure load 1863.3 (1969.2)
Failure location: N/A swage
7 1/8" - T inches from cable end
N/A other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04



8-6-04

Attachment #3

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly	SRB-QUAL-04-0064	Revision: Basic
QUALIFICATION TEST	Date: 7/26/04	Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 RT-3

Verify PQAR



8-6-04

* 6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

* 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

6.0.5 Photograph set-up.



8-6-04

* 6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

6.0.7 Begin video.



8-6-04

* 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



6.0.9 Document temperature of test article.

71°F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04

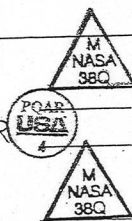


8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



86-04
86-04

6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 1899.4

Failure location:

N/A
3 1/2" - 7
N/A

swage
inches from cable end
other

Verify PQAR



86-04
86-04
86-04

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knocheimann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346
















86-04

Attachment #4

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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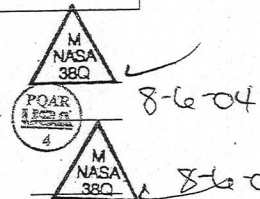
6.0 TEST OPERATION

- 6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures
Verify PQAR   8-6-04
- 6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 RT-1
Verify PQAR  8-6-04
- 6.0.3 Mount the Restraint Cable into the fixture.
Verify PQAR   8-6-04
- *6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.
Verify PQAR N/A  8-6-04
- 6.0.5 Photograph set-up.
- *6.0.6 Install furnace and heat to 1250F (HT tests only).
Verify PQAR N/A  8-6-04
- 6.0.7 Begin video.
- *6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):
Verify PQAR N/A
- 6.0.9 Document temperature of test article. 71 °F
Witness PQAR  8-6-04
- 6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.
Witness PQAR   8-6-04
- 6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 48.6 lbs
Verify PQAR   8-6-04
- 6.0.12 Continue increase load until failure occurs.:
Witness PQAR  8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



6.0.14 Stop video.

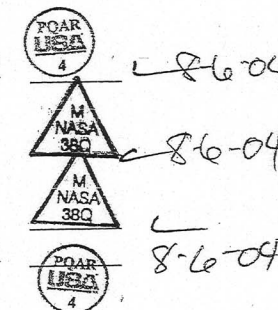
6.0.15 Document load and location of failure:

Failure load 2008.5

Failure location:

N/A swage
3 1/2" - 7 inches from cable end
N/A other

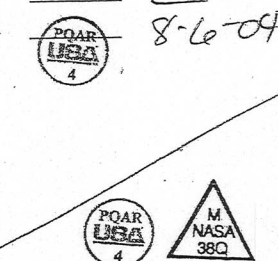
Verify PQAR



6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



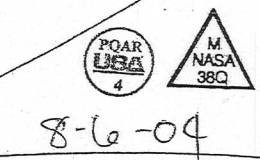
6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochemann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



Attachment #5

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 RT-5

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR

N/A



8-6-04

6.0.5 Photograph set-up.

*6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR

N/A



8-6-04

6.0.7 Begin video.

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR

N/A



6.0.9 Document temperature of test article.

71°F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

48.1 lbs

Verify PQAR



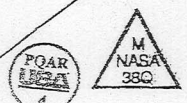
8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04

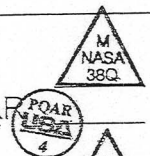


8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



86-04

6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 1981.6 lbs

Failure location:

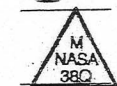
N/A swage
3/4 - 7 inches from cable end
N/A other

Verify PQAR



86-04

6.0.16 Photograph set-up.



86-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



86-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



86-04

Attachment #6

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

- 6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

- 6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 # E/L-6

Verify PQAR



8-6-04

- 6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

- 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

- 6.0.5 Photograph set-up.

- 6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

- *6.0.7 Begin video.

N/A

- 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04

- 6.0.9 Document temperature of test article. 1253

Witness PQAR



8-6-04

- 6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

- 6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 44.7

Verify PQAR



8-6-04

- 6.0.12 Continue increase load until failure occurs.

Witness PQAR



8-6-04



8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04



N/A

*6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 387.8 lbs

Failure location:

N/A

swage

5.0" - T

inches from cable end

N/A

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04



6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard KnocheImari (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

Attachment # 7

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 E/v-7

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

6.0.5 Photograph set-up.

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

*6.0.7 Begin video.

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04

6.0.9 Document temperature of test article.

1259 F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

*6.0.14 Stop video.

N/A

6.0.15 Document load and location of failure:

Failure load 370.6 lbs

Failure location:

N/A
SK - T
N/A

swage

inches from cable end

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



Attachment #8

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 E12-8

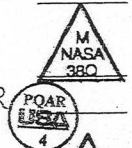
Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

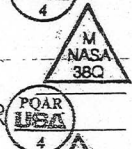
Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

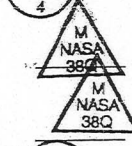
Verify PQAR



8-6-04

6.0.5 Photograph set-up.

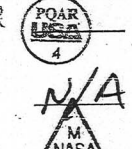
Verify PQAR



8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

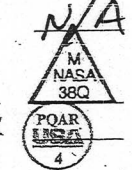
Verify PQAR



8-6-04

*6.0.7 Begin video.

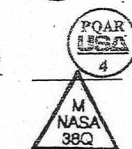
Verify PQAR



8-6-04

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Witness PQAR

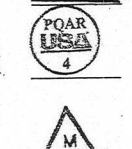


8-6-04

6.0.9 Document temperature of test article.

1251 °F

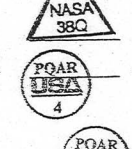
Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

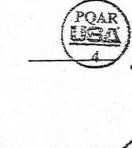
Verify PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Witness PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

*6.0.14 Stop video.

N/A

6.0.15 Document load and location of failure:

Failure load 399.8 lbs

Failure location:

N/A

swage

5 1/8" - 7

inches from cable end

N/A

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

Attachment #9

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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 E1K-9

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR



8-6-04

6.0.5 Photograph set-up.



8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR



8-6-04

~~6.0.7~~ Begin video.



6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR



8-6-04

6.0.9 Document temperature of test article.

1250°F

Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR



8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

43.7

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04



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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

N/A

*6.0.14 Stop video.

6.0.15 Document load and location of failure:

Failure load 392.7 lbs

Failure location:

N/A

swage

5 3/4" - T

inches from cable end

N/A

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

Pat Roberts (321) 867-1757

Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

Attachment #10

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR



8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test:

LOT 104236 EKV-10

Verify PQAR



8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

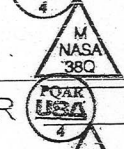
Verify PQAR



8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR

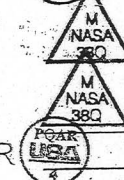


8-6-04

6.0.5 Photograph set-up.

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR

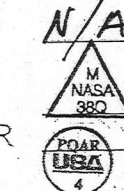


8-6-04

*6.0.7 Begin video.

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR

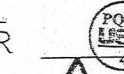


8-6-04

6.0.9 Document temperature of test article.

1251 °F

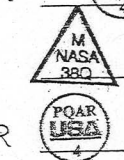
Witness PQAR



8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR

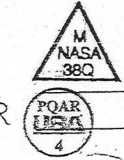


8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

42.7 lbs

Verify PQAR



8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR



8-6-04



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6.0.13 Verify load and instrumentation.

Verify PQAR



8-6-04

*6.0.14 Stop video.

N/A

6.0.15 Document load and location of failure:

Failure load 400.4 lbs

Failure location:

N/A
5 1/2" - T
N/A

swage

inches from cable end

other

Verify PQAR



8-6-04

6.0.16 Photograph set-up.



8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR



8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:

Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309

Cary Cox (321) 867-1757

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Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346



8-6-04

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4. “Terminal, Cable Assemblies, Swaged Type,” *MIL-T-6117*, Rev. D, Department of Defense, Philadelphia, PA, December 1, 1994.
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7. Martin, D.M.: “Contract NAS9-1000000, Submittal of United Space Alliance SRB Element Prepared Qualification Test Plan (QTP) 90PLN-0064, Revision Basic Dated 7/19/2004 for the Strut Retainer Assembly Aft Ring,” *MP41 (04-063)*, Marshall Space Flight Center, MSFC, AL, July 26, 2004.
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) George C. Marshall Space Flight Center Marshall Space Flight Center, AL 35812		8. PERFORMING ORGANIZATION REPORT NUMBER M-1172		
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13. ABSTRACT (Maximum 200 words) This Technical Memorandum presents qualification test results for solid rocket booster diagonal strut restraint cable part number 101276-00313-102/103. During flight this assembly is exposed to a range of temperatures. MIL-W-83420 shows the breaking strength of the cable as 798 kg (1,760 lb) at room temperature but does not define cable strength at the maximum temperature to which the cable is exposed during the first 2 min of flight; 669 °C (1,236 °F). The cable, which can be built from different corrosion resistant steel alloys, may also vary in its chemical, physical, and mechanical properties at temperature. Negative margins of safety were produced by analysis of the cable at temperature using standard knockdown factors. However, MSFC-HDBK-5 allows the use of a less conservative safety factor of 1.4 and knockdown factors verified by testing. Test results allowed a calculated knockdown factor of 0.1892 to be determined for the restraint cables, which provides a minimum breaking strength of 151 kg (333 lb) at 677 °C (1,250 °F) when combined with the minimum breaking strength of 0.317-cm (0.125- or 1/8-in) diameter, type 1 composition rope.				
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George C. Marshall Space Flight Center

Marshall Space Flight Center, Alabama

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